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Vol. I

TRANSCRIPT OF RECORD

(Pages 1 to 272)

Supreme Court of the United States

OCTOBER TERM, 1945

No. 290

HALLIBURTON OIL WELL CEMENTING COMPANY, PETITIONER,

vs.

CRANFORD P. WALKER AND CRANFORD P. WALKER, D. A. WALKER, ET AL., DOING BUSINESS AS DEPTHOGRAPH COMPANY, COPARTNERSHIP

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT

PETITION FOR CERTIORARI FILED AUGUST 8, 1945.

CERTIORARI GRANTED OCTOBER 15, 1945.

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CLERK

TRANSCRIPT OF RECORD
IN SIX VOLUMES

IN THE

Supreme Court of the United States

October Term, 1945

No. 290

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Petitioner,

vs.

CRANFORD P. WALKER and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as Depthograph Company, a copartnership,

Respondents.

VOLUME I

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UPON PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT

Rotary Coldprint, 661 Howard Street, San Francisco

No. 10513

United States
Circuit Court of Appeals
For the Ninth Circuit.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Appellant,

vs.

CRANFORD P. WALKER and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as Depthograph Company, a copartnership,

Appellees.

CRANFORD P. WALKER and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as Depthograph Company, a copartnership,

Appellants,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Appellee.

Transcript of Record

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Upon Appeals from the District Court of the United States for the Southern District of California, Central Division

Rotary Colorprint, 980 Folsom St., San Francisco

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[1*]

*Page numbering appearing at foot of page of original certified

In the United States District Court, Southern District of California, Central Division

No. 1655-H

Civil

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY, a co-partnership,

Plaintiffs,

v.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Defendant,

For Infringement of United States Letters Patent Nos. 2,156,519, 2,209,944 and Re. 21,383

[2]

BILL OF COMPLAINT

Now come Cranford P. Walker, and Cranford P. Walker, D. A. Walker, Robert P. Miller and Milo C. Ketchum, doing business as Depthograph Company, a co-partnership, plaintiff in the above entitled action, and complain of Halliburton Oil Well Cementing Company, a corporation, defendant herein, and for cause of action allege:

I.

That Cranford P. Walker at all of the times hereinafter mentioned was and is a citizen, inhabitant and resident of San Marino, County of

Los Angeles, State of California, within the Southern District of California, Central Division.

II.

That Cranford P. Walker, D. A. Walker, Robert P. Miller and Milo C. Ketchum, doing business as Depthograph Company, all reside within the County of Los Angeles, State of California, and that said co-partnership has a regular and established place of business at San Marino, County of Los Angeles, State of California, all within the Southern District of California, Central Division.

III.

That plaintiffs are informed and believe and therefore allege that Halliburton Oil Well Cementing Company is a corporation organized under the laws of the State of Delaware, and [3] has a regular and established place of business at Los Angeles, in the County of Los Angeles, State of California, within the Southern District of California, Central Division.

IV.

That the grounds upon which this Court's jurisdiction depends is that this is a suit arising under the patent laws of the United States.

V.

That on May 2, 1939 United States Letters Patent No. 2,156,519 were duly and legally issued to plaintiff Cranford P. Walker for an invention in Means for Measuring the Location of Obstructions in

Wells, and since that date plaintiff Cranford P. Walker has been and still is the owner of those Letters Patent.

VI.

That on June 6, 1939 United States Letters Patent No. 2,161,733 were duly and legally issued to plaintiff Cranford P. Walker for an invention in Method of Determining Fluid Density, Fluid Pressure, and the Production Capacity of Oil Wells, and Letters Patent were duly and legally reissued to plaintiff Cranford P. Walker as Reissue Letters Patent No. 21,383 on March 5, 1940, and since March 5, 1940, plaintiff Cranford P. Walker has been and still is the owner of those Letters Patent and Reissue Letters Patent.

VII.

That on July 30, 1940 United States Letters Patent No. [4] 2,209,944 were duly and legally issued to plaintiff Cranford P. Walker for an invention in Method of Measuring Location of Obstructions in Deep Wells, and since that date plaintiff Cranford P. Walker has been and still is the owner of those Letters Patent.

VIII.

That by agreements in writing between the said Cranford P. Walker and the Depthograph Company, a co-partnership, said agreements being dated, respectively, July 6, 1939, March 25, 1940, June 1, 1939 and August 27, 1940, the said Depthograph Company, a co-partnership, is the sole and exclusive licensee under said Letters Patent Nos. 2,156,510,

2,209,944 and Reissue Letters Patent No. 21,383, all as will more fully and at large appear by the originals of said license agreements, or by duly certified copies thereof, ready to be produced in court as may be requested.

IX.

That defendant Halliburton Oil Well Cementing Company has for a long time past and still is infringing each of said Letters Patent Nos. 2,156,510, 2,209,944 and Reissue Letters Patent No. 21,383, by making, selling, leasing and using apparatus for measuring the location of obstructions in wells and by practicing the methods of measuring location of obstructions in deep wells and determining fluid density, fluid pressure and production capacity of oil wells embodying the patented inventions, all within the Southern District of California and elsewhere, and will continue to do so unless enjoined by this Court. [5]

X.

That plaintiffs have given notice to defendant of its said infringement.

Wherefore, Plaintiffs pray:

(a) That a preliminary and final injunction issue against further infringement of said United States Letters Patent Nos. 2,156,519, 2,209,944 and Reissue Letters Patent No. 21,383, by defendant and those controlled by defendant.

(b) That defendant be ordered and decreed to account to plaintiffs for all gains, profits and advantages realized by defendant as a result of said

infringement of United States Letters Patent Nos. 2,156,519, 2,209,944 and Reissue Letters Patent No. 21,383, and that in addition to said gains, profits and damages to be so accounted for, the damages sustained by plaintiffs as a result of said infringement of said United States Letters Patent aforesaid.

(c) That plaintiffs may have and recover from defendant the costs to be taxed and have execution therefor.

(d) That plaintiffs may have such other and further relief in the premises as equity and good conscience may require.

HAROLD W. MATTINGLY
Attorney for Plaintiffs
720 Pacific Finance Bldg.
621 South Hope Street
Los Angeles, California
MA 1137

[Endorsed]: Filed Jul. 16, 1941. [6]

[Title of District Court and Cause.]

BILL OF PARTICULARS

Comes now plaintiffs, by their attorney, and in response to defendant's motion in that behalf, furnishes their Bill of Particulars pursuant to Rule 12 (e) of the Rules of Civil Procedure, as follows:

I.

Plaintiffs are not fully advised as to all of the methods and apparatus employed by the defendant

but as now advised, plaintiffs will rely upon and assert as infringing the Letters Patent in suit, each and every of the methods employed by defendant to perform any and all of the following: To measure the location of fluid levels and other obstructions and apparatus in oil wells, to determine subsurface pressures, to determine bottom-hole pressures, to determine fluid gradients, to determine production capacities, to determine well potentials and to determine productivity index of oil wells of the character referred to in the attached pamphlets entitled "An Echo Writes the Fluid Level of Your Well" marked plantiffs' Exhibit 1, and "Halliburton 'Echo-Meter' for accurate fluid level determinations", marked plaintiffs' Exhibit 2, and of the character referred to in the attached data sheets entitled "Echometer Field Data" and "Subsurface Pressure Test Data Potential Determination for Pumping Wells", marked plaintiffs' Exhibit 3, Sheets 1 to 5, respectively, and the apparatus employed by defendant to perform such mehods [7] of the character pictured in and referred to in plaintiffs' Exhibit 1.

II.

Plaintiffs are not fully informed as to the details of the apparatus employed by defendant for measuring the location of fluid levels and other obstructions but as at present advised will rely upon and assert as infringing the Letters Patent in suit the apparatus as recited in Paragraph I hereof.

III.

As at present advised, plaintiffs will rely upon and assert the following:

(a) As to defendant's method of measuring the location of fluid levels and other obstructions and apparatus in oil wells, Claims 1, 2, 3, 4, 5, 6, 7, 8 and 9 of Letters Patent No. 2,209,944, and Claims 1, 12, 13, 14, 15 and 17 of Letters Patent No. 2,156,519.

(b) As to defendant's method of determining subsurface pressures and bottom-hole pressures, Claims 5, 7, 9 and 10 of Reissue Letters Patent No. 21,383, and as to defendant's [8] step of measuring the fluid levels utilized in this method, those claims of Letters Patents Nos. 2,209,944 and 2,156,519 specified in subparagraph (a) hereof.

(c) As to defendant's method of determining fluid densities and fluid gradients, Claims 1, 2, 3, 4 and 5 of Reissue Letters Patent No. 21,383, and as to the step of measuring the fluid levels utilized in the method those claims of Letters Patent Nos. 2,209,944 and 2,156,519 specified in sub-paragraph (a) hereof.

(d) As to defendant's method of determining production capacities, well potentials and the productivity index of wells, Claims 8 and 11 of Reissue Letters Patent No. 21,383 and as to the steps of fluid densities or gradients utilized in the method, Claims 1, 2, 3, 4 and 5 of Reissue Letters Patents No. 21,383 and as to the step of measuring fluid levels utilized in this method, the claims of Letters

Patent No. 2,209,944 and No. 2,156,519, specified in sub-paragraph (a) hereof.

Dated at Los Angeles, California, this 21st day of October, 1941.

HAROLD W. MATTINGLY
Attorney for Plaintiffs.

A copy of the foregoing Bill of Particulars has been handed to Frank L .A. Graham, 811 West 7th Street, Los Angeles, California, attorney for defendant, on this 22nd day of October, 1941.

HAROLD W. MATTINGLY

[Endorsed]: Filed Oct. 22, 1941. [9]

(Copy)

[Title of District Court and Cause.]

AMENDED ANSWER OF DEFENDANT

Now comes the Defendant, Halliburton Oil Well Cementing Company, leave of court being first had thereto, and files this its Amended Answer to the Complaint herein, and says:

I.

Answering paragraph I of the Complaint, defendant is without knowledge or information sufficient to form a belief as to the truth of the allegation that Cranford P. Walker was and is a citizen, inhabitant and resident of San Marino, County of

Los Angeles, State of California and, therefore, denies the same.

II.

Answering paragraph II of the Complaint, defendant is without knowledge or information sufficient to form a belief as to the truth of the allegation that Cranford P. Walker, D. A. Walker, Robert P. Miller and Milo C. Ketchum are doing business as Depthograph Company, that they all reside in the County of Los Angeles, State of California; that the Depthograph Company is a co-partnership and that it has a regular and established place of business in the County of Los Angeles, State of California, and, therefore denies the same. [10]

III.

Answering paragraph III of the Complaint, defendant admits that the Halliburton Oil Well Cementing Company is a corporation organized under the laws of the State of Delaware and admits that it has a regular and established place of business at Los Angeles, County of Los Angeles, State of California, within the Southern District of California, Central Division.

IV.

Answering paragraph IV of the Complaint, defendant admits that this is an action for infringement of letters patent of the United States and defendant admits the jurisdiction of this Honorable Court.

V.

Answering paragraph V of the Complaint, defendant admits that Letters Patent No. 2,156,519 was issued to plaintiff, Cranford P. Walker on May 2, 1939, but denies that the same was duly and legally issued. Defendant is without knowledge or information sufficient to form a belief as to the truth of the allegation that Cranford P. Walker is the owner of said patent and, therefore denies the same.

VI.

Answering paragraph VI of the Complaint, defendant admits that Letters Patent No. 2,161,733 issued to Cranford P. Walker on June 6, 1939, but denies that the same was duly and legally issued. Defendant admits that Letters Patent No. 2,161,733 was reissued to Cranford P. Walker as Reissue No. 21,383, on March 5, 1940, but denies that the same was duly and legally reissued. Defendant is without knowledge or information sufficient to form a belief as to the truth of the allegation that Cranford P. Walker is the owner of said reissue letters patent, and therefore, denies the same. [11]

VII.

Answering paragraph VII of the Complaint, defendant admits that Letters Patent No. 2,209,944 issued to Cranford P. Walker on July 30, 1940, but denies that the same was duly and legally issued. Defendant is without knowledge or information sufficient to form a belief as to the truth of the

allegation that Cranford P. Walker is the owner of said patent and, therefore, denies the same.

VIII.

Answering paragraph VIII of the Complaint defendant is without knowledge of any agreement between Cranford P. Walker and the Depthograph Company; is without knowledge or information sufficient to form a belief as to the truth of the allegation that the Depthograph Company is a copartnership; or that the Depthograph Company is the sole and exclusive licensee under Letters Patent No. 2,156,519, No. 2,209,944 and Reissue Patent No. 21,383 and, therefore, denies the same.

IX.

Answering paragraph IX of the Complaint, defendant admits that it has made, sold, leased and used apparatus for measuring the location of obstructions in wells and admits that it has practiced methods of measuring the location of obstructions in wells and defendant admits that it has determined fluid density, fluid pressure and production capacity of oil wells within the Southern District of California and elsewhere; but denies that it has infringed the claims of any of said letters patent, within the Southern District of California or elsewhere, and denies that it will do so unless enjoined by this Honorable Court.

X.

Answering paragraph X of the Complaint, defendant denies that plaintiff has given due notice

of alleged infringement of the letters patent mentioned in the Complaint. [12]

With reference to the Bill of Particulars filed herein by the plaintiff on or about the 21st day of October, 1941, defendant says:

XI.

In answer to paragraph I of the Bill of Particulars, defendant admits that it measures the location of fluid levels and other obstructions and apparatus in oil wells, to determine sub-surface pressures, to determine bottom hole pressures, to determine production capacities, to determine well potentials and to determine productivity index of oil wells, of the character referred to in plaintiff's Exhibits 1 and 2 attached to said Bill of Particulars, but denies that the methods disclosed and described in said exhibits or any methods or apparatus employed by defendant in any way infringe the claims of any of the letters patent here in suit. Defendant admits that in a few isolated instances, employees of defendant have determined fluid gradient, as, for example, in plaintiff's Exhibit #3 attached to said Bill of Particulars, and as alleged in paragraph I thereof, but denies that the method thus used to determine fluid gradient is an infringement of the claims of any of the Letters Patent here in suit. Defendant alleges that the determination of fluid gradient to the best of its knowledge and belief, has only been made long prior to the filing of the Complaint herein by employees of defendant only in ten (10) wells; that to the best of

the knowledge and belief of defendant, no charge was made for such determination and no profit derived therefrom by defendant.

XII.

Answering paragraph II of the Bill of Particulars, defendant admits that it has used the apparatus shown and described in plaintiff's Exhibits 1 and 2 accompanying the Bill of Particulars, but denies that said apparatus is an infringement of the claims of any of the letters patent here in suit.

[13]

XIII.

(a) Answering paragraph III (a) of the Bill of Particulars, defendant denies that its method of measuring the location of fluid levels and other obstructions and apparatus in oil wells is in infringement of claims 1 to 9 inclusive, of Letters Patent No. 2,209,944 and of claims 1, 12, 13, 14, 15 and 17 of Letters Patent No. 2,156,519.

(b) Answering paragraph III (b) of the Bill of Particulars, defendant denies that its method of determining sub-surface pressures and bottom hole pressures is in infringement of claims 5, 7, 9 and 10 of Reissue Letters Patent No. 21,383, and defendant denies that its steps of measuring the fluid levels utilized in its method is in infringement of those claims of Letters Patent Nos. 2,209,944 and 2,156,519 specified in paragraph III (a) of the Bill of Particulars.

(c) Answering paragraph III (c) of the Bill of Particulars, defendant admits that its employees

have, in a few isolated cases, determined fluid density or fluid gradient, but denies that such determinations were in infringement of claims 1 to 5, inclusive, of Reissue Patent No. 21,383. Defendant alleges that the acts involved in said isolated cases are trivial and to the best of knowledge and belief of officers of defendant, were discontinued long prior to the bringing of this suit. Defendant denies that the acts admitted in this paragraph constituted infringement of those claims of Letters Patent No. 2,209,944 and 2,156,519 specified in paragraph III (a) of the Bill of Particulars.

(d) Answering paragraph III (d) of the Bill of Particulars, defendant denies that its method of determining production capacities, well potentials, and the productivity index of wells is in infringement of claims 8 and 11 of Reissue Patent No. 21,383. Defendant denies that the few isolated cases where it has performed the steps of determining fluid densities or gradients were in in- [14] fringement of claims 1, 2, 3, 4 and 5 of Reissue Patent No. 21,383. Defendant denies that the method it employs for measuring fluid levels is in infringement of the claims of Letters Patent 2,209,944 and 2,156,519, specified in paragraph III (a) of the Bill of Particulars.

Further answering the Complaint:

XIV.

Defendant alleges that this action is barred in equity because of unconscionable conduct on the part of plaintiff. Defendant alleges that prior to

any alleged invention of any of the patents in suit, one Paul E. Lehr and one Harold T. Wyatt, patentees of U. S. Patent No. 2,047,974, had, in public use, certain methods and apparatus for measuring well depths, and certain methods and apparatus for determining density of fluid in a well, which methods and apparatus were the same or similar to methods and apparatus asserted to infringe the patents in suit; that plaintiffs have entered into one or more contracts with said Lehr and said Wyatt, the effect of which contract or contracts was intended to be, and is, either by express terms or implied conditions:

(a) To suppress evidence as to the prior public use by Lehr or Wyatt.

(b) To make Lehr and Wyatt adverse or unwilling witnesses for defendant.

(c) To cause Lehr and Wyatt to make laudatory statements as to the alleged inventions of plaintiff and derogatory statements as to their own prior invention, contrary to the facts.

(d) To make Lehr and Wyatt financially interested in the outcome of this lawsuit.

XV.

Defendant alleges that plaintiff has asserted and is asserting in this action, a broad and dominating monopoly wholly un- [15] supported by any invention made by Cranford P. Walker, plaintiff, and wholly unsupported by any invention disclosed by the patents in suit.

XVI.

Defendant alleges upon information and belief, that the letters patent in suit and particularly the claims thereof herein charged to be infringed, and each of them, were so restricted and limited in scope by the procedure in the Patent Office in connection with the applications for the letters patent in suif, divisions, continuations and parent applications, and other applications pending at the same time, relating to the same or similar subject matter, that such claims and each of them, if valid at all, are not entitled to any construction which will include or cover any method or apparatus manufactured, sold or used by defendant; wherefore, defendant denies infringement of any of the claims of said letters patent.

XVII.

Defendant alleges that the claims of the letters patent in suit herein charged to be infringed, cover mere aggregation or old combinations of elements or method steps, and not new patentable combina-

tions or methods and are, therefore, invalid under the law.

XVIII.

Defendant alleges that the claims of the letters patent in suit herein charged to be infringed, distinguish over the prior art existing at the time of the alleged inventions only by the substitution of known equivalent elements or steps of the prior art, and are, therefore, invalid.

XIX.

Defendant alleges that the claims of Letters Patent No. 2,156,519 charged to be infringed by this defendant, are invalid and void for the following reasons: [16]

(a) That the apparatus described and claimed in each of claims 1, 12, 13, 14, 15, and 17, here in suit, or material and substantial parts thereof, were patented or described in printed publications prior to the alleged invention or discovery thereby by Cran-

ford P. Walker, or more than two years prior to his application for said letters patent as follows:

U. S. Patents		Date
Batcheller	602,422	April 19, 1898
Fessenden	1,217,585	Feb. 27, 1917
Fessenden	1,240,328	Sept. 18, 1917
Tucker	1,351,356	Aug. 31, 1920
Behm	1,649,378	Nov. 15, 1927
Williams	1,671,262	May 29, 1928
Dorsey	1,730,411	Oct. 8, 1929
Taylor	1,847,636	March 1, 1932
Smith	2,008,934	July 23, 1935
Gilmore	2,021,774	Nov. 19, 1935
Lehr et al	2,047,974	July 21, 1936
Kunze	2,116,523	May 10, 1938
Scott	2,173,426	Sept. 19, 1939
Halliburton	2,201,311	May 21, 1940

British patent to William S. Tucker No. 138,-368 for "Improvements in and Relating to Microphones", complete accepted May 22, 1917 and published January 20, 1920;

British patent of addition to William S. Tucker, No. 195,199 for "Improvements in and Relating to Hot Wire Microphones", complete accepted March 29, 1923;

An article entitled "Hot-Wire Microphone and its Application to Problems of Sound" by Major W. S. Tucker, of Thames Ditton, England, appearing on pages 121 to 137 inclusive, of the "Journal of the Royal Society of Arts", Vol. LXXI, No. 3659 of January 5, 1923.

and also other patents and printed publications, the names, numbers, dates and authors of which are not at present known to defendant, but which, when ascertained, defendant prays leave to add hereto.

(b) That the apparatus described and claimed in each of claims 1, 12, 13, 14, 15 and 17 of Letters Patent No. 2,156,519, in suit, do not involve inven-

tion over the prior art cited in paragraph [17] XIX (a) hereof but represent, at most, the exercise of mere skill in the art.

(c) That Cranford P. Walker was not the original and first inventor or discoverer of the things defined in claims 1, 12, 13, 14, 15 and 17, of Letters Patent No. 2,156,519 or of any material or substantial part thereof, but prior to the alleged invention thereof by Cranford P. Walker, the same were, if invention be involved therein, invented by or known to the patentees listed in paragraph XIX (a) hereof, at the addresses given in the Letters Patent or publications and also by others not now known to defendant but which, when ascertained, defendant prays leave to add hereto.

XX.

Defendant alleges that the matter purported to be covered by Letters Patent No. 2,156,519 is not a statutory subject of a patent, and that the same is, therefore, invalid and void.

XXI.

Defendant alleges that claims 1, 12, 13, 14, 15 and 17 of Patent No. 2,156,519 are not distinct in that they do not particularly point out or distinctly claim the part, improvement or combination which the patentee claims as his invention, as required by law, and that, therefore, said claims are invalid and void.

XXII.

Defendant alleges that the claims of Letters Patent No. 2,209,944 charged to be infringed by this

defendant, are invalid and void for the following reasons:

(a) That the methods described and claimed in each of the claims thereof, or material and substantial parts thereof, were patented or described in print- [18] ed publications prior to the alleged invention or discovery thereof by Cranford P. Walker, or more than two years prior to this application for said letters patent as follows:

The Prior Art Cited in Paragraph XIX (a) Hereof, and also other patents and printed publications, the names, numbers, dates and authors of which are not at present known to defendant but, which, when ascertained, defendant prays leave to add hereto.

(b) That the method described and claimed in each of the claims of Letters Patent No. 2,209,944 in suit, do not involve invention over the prior art cited in paragraph XIX (a) hereof, but represent, at most, the exercise of mere skill in the art.

(c) That Cranford P. Walker was not the original and first inventor or discoverer of the method patented in Letters Patent No. 2,209,944, or of any material or substantial part thereof; but prior to the alleged invention thereof by Cranford P. Walker, the same were, if invention be involved therein, invented by or known to the patentees listed in paragraph XIX (a) hereof, at the addresses given in the patents and also by others not now known to defendant, but which, when ascertained, defendant prays leave to add hereto.

XXIII.

Defendant alleges that the matter purported to be covered by the claims of Letters Patent No. 2,209,944 is not a statutory subject of a patent, and that the same is, therefore, invalid and void. [19]

XXIV.

Defendant alleges that the claims of Letters Patent No. 2,209,944 are not distinct, in that they do not particularly point out or distinctly claim the steps, improvement or part of the method which the patentee claims as his invention, as required by law, and that, therefore, said claims are invalid and void.

XXV.

Defendant alleges that said Letters Patent No. 2,209,944 is utterly void because granted in violation of R.S. Sec. 4886 (U.S.C. title 35 sec. 21), the method described and claimed in said Patent No. 2,209,944, having been in public use in the United States more than two years prior to the date of application (Serial No. 296,781) on which said Letters Patent No. 2,209,944 was granted.

Defendant alleges further that said application (Serial No. 296,781) on which said Letters Patent No. 2,209,944 was granted, was filed September 25, 1939.

Defendant alleges further that the identical method of said Letters Patent No. 2,209,944 was put in public use in the United States by Cranford P. Walker, patentee, on March 6, 1937 on a well owned by the Rio Grande Oil Company at or

near Maricopa, California and that subsequently, but more than two years prior to said filing date of September 25, 1939, the method identical with that of said Letters Patent No. 2,209,944 was placed in public use in the United States, on hundreds of other wells, by said Cranford P. Walker.

Accordingly, defendant alleges that said Cranford P. Walker abandoned the alleged invention of said Letters Patent 2,209,944 by not applying for a patent on it during the time allowed by the statutes for such an application.

XXVI.

Defendant alleges that said application (Serial No. 296,781) which matured into Letters Patent No. 2,209,944 was filed in violation of the Statutes of the United States in effect on its filing [20] date, September 25, 1939 and that the same is, therefore, wholly void; and particularly in that said application is in violation of the repeal (By H.R. 6874, effective August 9, 1939) of R.S. Sec. 4897 (U.S.C. title 35, sec. 38); that said application (Serial No. 296,781) is an application for patent for the same alleged invention or discovery upon which said Cranford P. Walker had previously applied for patent, by an application Serial No. 270,865, filed April 29, 1939, which previous application had been allowed on September 14, 1939 (after the repeal of R.S. 4897) with notice to said Cranford P. Walker that it could not be renewed; that said Cranford P. Walker, in disregard of said notice and in evasion of the repeal of the statute which for-

merly had authorized such renewal of application for patent (R.S. Sec. 4897), did nevertheless renew his application for patent (Serial No. 296,781) and obtained Patent No. 2,209,944 here in suit, in violation of the law.

XXVII.

Defendant alleges that the claims of Letters Patent Reissue No. 21,383, charged to be infringed by this defendant, are invalid and void for the following reasons:

(a) That the methods described and claimed in each of claims 1 to 5, inclusive, and 7 to 11, inclusive, or material and substantial parts thereof, were patented or described in printed publications prior to the alleged invention or discovery thereof by Cranford P. Walker, or more than two years prior to his application for the original patent upon which said reissue was granted, as follows:

U. S. Patents	Date
Batcheller—602,422	April 19, 1898
Lehr—2,047,974	July 21, 1936

[21]

PUBLICATIONS

An article entitled "A Method of Determining Production Allowances in Prorated Fields", by H. D. Wilde, Jr. and T. V. Moore, appearing on pages 71 to 77 of Production Bulletin No. 207 of the American Petroleum Institute, published June 30, 1931.

An article entitled "Sub-Surface Pressures in Oil Wells", by D. G. Hawthorn, appearing on pages 148 to 169 of Volume 103 of the Transactions of the American Institute of Mining and Metallurgical Engineers, published in 1933.

An article entitled "Bottom Hole Pressure Bomb Aids in Selection of Equipment for Wells", by Harold Ihrig, appearing on page 32 of the Oil and Gas Journal, of October 17, 1935.

An article entitled "New Apparatus for Precise Measurement of Bottom Hole Pressures", by S ı-ley Gill, appearing on pages 27 to 32 of "The Oil Weekly" for April 4, 1932.

An article entitled "Reservoir Pressures in the Hobbs Field, New Mexico", by R. S. Christie, of

Longview, Texas, appearing on pages 342-352 inclusive, of "Petroleum Development and Technology" copyright 1932 by American Institute of Mining and Metallurgical Engineers;

An article entitled "Determination and Application of Depth Pressures in the Yates Field" by Dale Nix of Iraan, Texas, appearing on pages 353 to 366 inclusive, of "Petroleum Development and Technology", copyright 1932 by American Institute of Mining and Metallurgical Engineers;

An article entitled "Bottom-Hole Pressures in Oil Wells" by C. V. Milikan of Tulsa, Oklahoma and Carroll V. Sidwell of Seminole, Oklahoma, appearing on pages 194 to 205 inclusive, of "Petroleum Development and Technology" copyright 1931 by American Institute of Mining and Metallurgical Engineers;

An article entitled "Density of Oil-Gas Columns from Well Data" by William V. Vietti, of Wink, Texas, appearing on pages 215 to 220 inclusive of "Petroleum Development and Technology" copyright 1931 by American Institute of Mining and Metallurgical Engineers.

and also other patents and printed publications, the names, numbers, dates and authors of which are not at present known to defendant but, which, when ascertained, defendant prays leave to add hereto.

(b) That the methods described and claimed in each of claims 1 to 5, inclusive, and 7 to 11, inclusive, of Letters Patent Reissue No. 21,383 in suit, do not involve invention over the prior art cited in paragraph XXVII (a) hereof, but represent, at most, the exercise of mere skill in the art.

(c) That Cranford P. Walker was not the original and first inventor or discoverer of the things [22] patented by Reissue No. 21,383, or of any material or substantial part thereof, but prior to the alleged invention thereof by Cranford P. Walker, the same were, if invention be involved therein, invented by or known to the patentees or authors listed in paragraph XXVII (a) hereof, at the addresses given in the letters patent and publications and also by others not now known to defendant

but, which, when ascertained, defendant prays leave to add hereto.

XXVIII.

Defendant alleges that the matter covered by Letters Patent Reissue No. 21,383 is not a statutory subject of a patent, and that the same is, therefore, invalid and void.

XXIX.

Defendant alleges that claims 1 to 5, inclusive, and 7 to 11, inclusive, of Letters Patent Reissue No. 21,383 are not distinct in that they do not particularly point out and distinctly claim the steps, improvements or part of the method, which the patentee claims is his invention, as required by law, and that, therefore, said claims are invalid and void.

XXX.

Defendant alleges that Letters Patent Reissue No. 21,383 is invalid and void because the original Patent No. 2,161,733 was surrendered and reissued in the absence of any statutory foundation therefor.

XXXI.

Defendant alleges that there was no inadvertence, accident or mistake in failing to claim in original Patent No. 2,161,733, all that is claimed in Reissue Patent No. 21,383, and that, therefore, said reissue is invalid and void. [23]

XXXII.

Defendant alleges that Letters Patent Reissue No. 21,383 in suit, covers a different invention from any which original Patent No. 2,161,733 shows was intended to be secured thereby and, that said reissue is, therefore, invalid and void.

XXXIII.

Defendant alleges that the Commissioner of Patents exceeded his legal authority in granting Letters Patent Reissue No. 21,383, and that the same is, therefore, invalid and void.

XXXIII-A

Further answering said complaint defendant alleges that Cranford P. Walker the alleged patentee of the patents in suit is not the original or first inventor or discoverer of the alleged inventions or any material or substantial part thereof purported to be covered by the claims in said Letters Patents in suit or any of them in that the said Letters Patents and each of them is invalid and void for the following reasons:

(a) Because that which is alleged to be patented by said Letters Patents and each of them and particularly that which is described in the claims thereof and all material and substantial party thereof had been in public use more than two years prior to the filing of the respective applications for said Letters Patents in suit thereof by the said Cranford P. Walker, by each of the persons whose names, residences and places of public use are as follows:

Harold T. Wyatt, 515 No. Reeder Street, San Dimas, California; at Signal Hill and Dominguez Oil Fields in Los Angeles County, State of California;

Paul E. Lehr, 219 Monte Vista Drive, Bakersfield, California; at Signal Hill and Dominguez Oil Fields in Los Angeles County, State of California, and at Ventura, California;

Shell Oil Company, Inc., at Signal Hill and Dominguez Oil Fields in Los Angeles County, State of California; and

Union Oil Company of California at Dominguez Oil Field, Los Angeles County, State of California.

(b) Because that which is alleged to be patented by said Letters Patents and each of them and particularly that which is described in the claims thereof and all material and substantial parts thereof had been known or used in the United

States more than two years prior to the filing of the respective applications for said Letters Patents in suit or prior to the alleged invention thereof by the said Cranford P. Walker, by each of the persons whose names and residences are given in paragraph (a) above.

XXXIV.

Defendant denies that it has used any method or any apparatus within the Southern District of California or elsewhere which infringes upon any of the said letters patent or any claim thereof.

Wherefore, defendant prays that said Letters Patent Nos. 2,156,519, 2,209,944 and Reissue No. 21,383 be declared invalid and of no force and effect; that defendant be declared not to infringe the aforesaid letters patent, or any claims thereof; that the cost herein be taxed against the plaintiff and that the Complaint herein be dismissed, and for such other and different relief as the Court may deem just and equitable.

FRANK L. A. GRAHAM,
811 West Seventh Street, Los Angeles, California.
EARL BABCOCK,
Duncan, Oklahoma.
Attorneys for Defendant.

State of California,
County of .....—ss.

.....

being by me first duly sworn, deposes and says: That he is.....

.....

.....

in the foregoing and above entitled action: that he has.....read the foregoing.....

.....

and knows the contents thereof; and that the same is true of h.....own knowledge, except as to the matters which are therein stated upon h.....information or belief, and as to those matters that he believes it to be true.....

.....

Subscribed and Sworn to before me this.....day of....., 19.....

.....

.....

Notary Public in and for said County and State.

[Notarial Seal]

[Endorsed]: Filed Apr. 13, 1942. [24]

[Title of District Court and Cause.]

FINDINGS OF FACT AND CONCLUSIONS OF LAW

This cause having come on regularly to be heard in open court upon the issues raised by the Bill

of Complaint, Answer, Amended Answer and Amendment to Amended Answer and evidence, oral, documentary and physical, having been introduced and this Court having fully considered the same, together with the arguments of counsel, the Court makes the following findings of fact and conclusions of law, to-wit:

FINDINGS OF FACT

1. This is a suit involving the questions of validity and infringement of United States Letters Patent No. 2,156,519, No. 2,209,944 and Reissue No. 21,383, granted to Plaintiff, Cranford P. Walker, who is the owner of said Letters Patent and under which Depthograph Company, a co-partnership, is the exclusive licensee.

2. Plaintiffs reside within the County of Los Angeles, State of California and within the Southern District of California, Central Division.

3. Defendant, Halliburton Oil Well Cementing Company, a Delaware corporation, has a regular and established place of business at Los Angeles, County of Los Angeles, State of California and within the Southern District of California, Central Division.

4. The patents in suit are improvement patents and relate to means and methods for measuring the location of obstructions [25] and fluid levels in wells and in using the measurements thus obtained for making calculations of conditions in the well.

5. Prior to the patents in suit it was not new to fire a gun into a pipe and mechanically record

he echo from an obstruction in the pipe and it was not new to inject into a well casing a charge of gas from a cylinder of gas under pressure and record electrically the echoes from obstructions in the well.

6. Patent No. 2,156,519 is an apparatus patent and the apparatus disclosed includes mechanism for creating in the well a pressure wave caused by the sudden introduction of pressure into the well casing or the sudden release of pressure from the casing, a tuned acoustical resonator for accenting reflections from tubing collars or other apparatus or equipment in the well which diminishes or enlarges the annular space in the well at known regular intervals, a diaphragm actuated by pressure caused by the echoes and a mechanical, optical translating and recording mechanism for recording the echoes upon a tape together with mechanism for recording on the tape time intervals. This apparatus differs from and is an improvement over the prior art in the incorporation in such apparatus of a tuned acoustical means which performs the function of a sound filter as described in Claims 1, 13, 14, 15 and 17. This improvement involves invention over the prior art.

7. Walker patent No. 2,209,944 is a method patent and discloses and claims certain methods of determining the locations of obstructions in a well by introducing into the well a pressure [26] wave and the recording of echoes from the various known obstructions or partial obstructions in the well and calculating from information so acquired the lo-

cation of the obstructions. The novelty of this patent consists only in the performance of mental steps such as "counting," "observing," "computing" and "comparing", which do not involve invention.

8. The Walker Reissue Patent No. 21,383 is a method patent and discloses and claims methods of determining fluid density, fluid pressure and production capacity of an oil well by measuring two fluid levels and the pressure thereon and calculating using such information. The claimed methods differ from the prior art in the steps of measuring a fluid level under one condition of gas pressure in the well, measuring the gas pressure on the fluid, altering said gas pressure and again measuring the fluid level and gas pressure on the fluid, and from data thus obtained calculating the fluid density, fluid pressure or production capacity. These methods involve invention over the prior art.

9. Defendant manufactures and uses means for measuring the location of obstructions and fluid levels in wells and uses the measurements thus obtained in making calculations of conditions in the well. Defendant's apparatus consists of a gun and an electrical recording system composed of a hot wire microphone, an amplifier and a recorder, and in addition, an electrical filter incorporated in the amplifier circuit. The electrical filter is the equivalent of the acoustical tuned resonator of Patent No. 2,156,519 and when [27] the filter or an equivalent is used defendant's apparatus infringes

Claims 1, 13, 14, 15 and 17 of Patent No. 2,156,519 in suit.

10. Defendant's methods of determining pressure below the fluid surface, determining fluid gradient or density of the fluid in the fluid column or determining the production capacity of a well which involves the steps of taking two gas pressure measurements and two corresponding fluid level measurements and comparing them arithmatically or graphically is an infringement of the claims of Reissue Patent No. 21,383.

CONCLUSIONS OF LAW

I.

This is a case arising under Patent Laws of the United States and this Court has jurisdiction of the parties and the subject-matter.

II.

Plaintiff, Cranford P. Walker, is the owner of United States Letters Patents 2,156,519; 2,209,944 and Reissue 21,383 in suit and plaintiff, Depthograph Company, a co-partnership, is the owner of the exclusive license rights thereunder.

III.

That Letters Patent 2,156,519 is good and valid in law as to each of Claims 1, 13, 14, 15 and 17 in suit.

IV.

That each of Claims 1, 13, 14, 15 and 17 of Letters Patent No. 2,156,519 has been infringed by the defendant. [28]

V.

That Reissue Letters Patent No. 21,383 is good and valid in law as to each of the claims thereof.

VI.

Each of the claims of said Walker Reissue Patent No. 21,383 has been infringed by defendant.

VII.

Walker patent No. 2,209,944 is invalid as to each of the claims thereof as defining methods which do not involve invention and are unpatentable.

VIII.

Plaintiffs are entitled to a permanent injunction against further infringement of Letters Patent No. 2,156,519 and Reissue Letters Patent No. 21,383 and to recover profits and damages arising out of past infringement.

Apr. 22, 1943.

PEIRSON M. HALL,
Judge.

Approved as to Form.

HAROLD W. MATTINGLY,
ROBERT W. FULWIDER,
Attorneys for Plaintiffs.
FRANK L. A. GRAHAM,
EARL BABCOCK,
Attorneys for Defendant.

[Endorsed]: Filed Apr. 22, 1943. [29]

District Court of the United States, Southern District of California, Central Division

No. 1655-PH Civil

CRANFORD P. WALKER, et al.,

Plaintiffs,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,

Defendant. [30]

DECREE

This cause having come on to be heard and evidence, oral, documentary and physical, having been introduced and this Court having fully considered the same, together with arguments of counsel, It Is Ordered, Adjudged and Decreed as Follows:

I.

That plaintiff Cranford P. Walker is the owner of United States Letters Patents Nos. 2,156,519, 2,209,944 and Reissue 21,383, and plaintiff Depthograph Company, a co-partnership, is the owner of the exclusive license rights thereunder, and said plaintiffs are the owners of all rights of action and recovery for infringement of said Letters Patents.

II.

That United States Letters Patent No. 2,156,519 is good and valid in law and particularly as to Claims 1, 13, 14, 15 and 17 thereof.

III.

That United States Reissue Letters Patent No. 21,383 is good and valid in law as to each of the claims thereof.

IV.

That United States Letters Patent No. 2,209,944 is invalid as to each of the claims thereof as defining methods which do not involve invention and which are not patentable. [31]

V.

That the defendant Halliburton Oil Well Cementing Company has infringed said United States Letters Patent No. 2,156,519 and particularly Claims 1, 13, 14, 15 and 17 thereof.

VI.

That the defendant Halliburton Oil Well Cementing Company has infringed United States Reissue Letters Patent No. 21,383 and particularly each and every of the claims thereof.

VII.

That a permanent injunction issue out and under the seal of this Court directed to the defendant Halliburton Oil Well Cementing Company, its agents, servants, employees, associates and attorneys and those in active concert and participating with them or any of them, permanently enjoining and restraining them and each of them from directly or indirectly in any manner making, using or selling or causing to be made, used or sold any appara-

tus for measuring the location of fluid levels or obstructions in wells covered by Claims 1, 13, 14, 15 and 17 of said United States Letters Patent No. 2,156,519, and permanently enjoining and restraining them and each of them from directly or indirectly in any manner infringing U. S. Letters Patent Number Reissue 21,383 by using, practicing or selling or causing to be used, practiced or sold any method for determining pressure in the fluid column of a well, or determining density of the fluid in the fluid column of a well, or determining the production capacity, productivity index or potential of a well which includes the steps of taking two gas [32] pressure measurements and two corresponding fluid level measurements and comparing them.

VIII.

That the plaintiffs recover from the defendant Halliburton Oil Well Cementing Company the profits made by said defendant and the damages suffered by plaintiffs arising out of or accruing from said infringement by the defendant Hall burton Oil Well Cementing Company, and that in the event plaintiffs and defendant cannot agree upon the amount of such profits and damages, then upon application of plaintiffs to this Court, this Court will appoint a Special Master and refer this cause to him to ascertain such profits and damages and to report the same to this Court.

IX.

That plaintiffs and defendant must each bear its own costs.

Apr. 22, 1943.

PEIRSON M. HALL,
United States District Judge.

Approved as to Form.

HAROLD W. MATTINGLY,
ROBERT W. FULWIDER,
Attorneys for Plaintiffs.
FRANK L. A. GRAHAM,
EARL BABCOCK,
Attorneys for Defendant.

Judgment entered Apr. 22, 1943. Docketed April 22, 1943. C. O. Book 16, Page 240. Edmund L. Smith, Clerk. By J. M. Horn, Deputy.

[Endorsed]: Filed Apr. 22, 1943. [33]

[Title of District Court and Cause.]

NOTICE OF APPEAL

Notice is hereby given that Halliburton Oil Well Cementing Company, defendant herein, hereby appeals to the Circuit Court of Appeals for the Ninth Circuit from the Judgment and Decree entered in this action on the 22nd day of April, 1943, insofar as said Judgment and Decree holds Letters Patent of the United States No. 2,156,519 and Reissue Letters Patent No. 21,383 valid and infringed, and

from the granting of the injunction and accounting thereon.

Dated this 12th day of May, 1943, Los Angeles, California.

FRANK L. A. GRAHAM,
WILLIAM R. GRAHAM,
EARL BABCOCK,
Attorneys for Defendant.

[Endorsed]: Filed & mailed copy to Harold W. Mattingly, Attorney for Plf. May 12, 1943, 1:40 P. M. Edmund L. Smith, Clerk. By John A. Childress, Deputy Clerk. [34]

[Title of District Court and Cause.]

COST BOND ON APPEAL

Than we, Halliburton Oil Well Cementing Company, a Delaware corporation, principal and Fidelity and Deposit Company of Maryland, as surety, are held and firmly found unto Cranford P. Walker; and Cranford P. Walker, D. A. Walker, Robert F. Walker and Milo C. Ketchum doing business as Depthograph Company, plaintiffs in the above named and numbered cause, in the sum of Two Hundred and Fifty ($250.00) Dollars, lawful money of the United States, to be paid to them, their successors and assigns; to which payment well and truly be made, we bind ourselves and each of us,

jointly and severally, and each of our successors and assigns by these present. [35]

Executed and Dated this 1st day of June, 1943, A.D.

Whereas, the above named Halliburton Oil Well Cementing Company, a Delaware Corporation, has prosecuted an appeal to the Honorable United States Circuit Court of Appeals for the Ninth Circuit to reverse the Decree of the District Court for the Southern District of California in the above entitled cause;

Now, Therefore, the condition of this obligation is such that if the above named Halliburton Oil Well Cementing Company, a Delaware Corporation, shall prosecute the said appeal to effect and answer all costs if it fails to make good its plea, then this obligation shall be void, otherwise to remain in full force and effect.

HALLIBURTON OIL WELL CEMENTING COMPANY,
By A. D. STODDARD,
Vice-President.
Attest: L. D. CAMBELL,
Secretary.

FIDELITY AND DEPOSIT COMPANY OF MARYLAND.
By D. E. GORTON,
Attorney in Fact.
Attest: S. M. SMITH,
Agent.

Approved: PEIRSON M. HALL,
Judge.

June 7, 1943.

State of California,
County of Los Angeles—ss.

On this 1st, day of June, 1943, before me, Theresa Fitzgibbons, a Notary Public, in and for the said County of Los Angeles, State of California, residing therein, duly commissioned and sworn, personally appeared D. E. Gorton, known to me to be the Attorney-in-Fact, and S. M. Smith, known to me to be the Agent of the Fidelity and Deposit Company of Maryland, the Corporation that executed the within instrument, and acknowledged to me that they subscribed the name of the Fidelity and Deposit Company of Maryland thereto and their own names as Attorney-in-Fact and Agent, respectively.

[Seal] THERESA FITZGIBBONS,
Notary Public in and for the County of Los Angeles, State of California.
My Commission Expires May 3, 1946.

[Endorsed]: Filed June 7, 1943. [36]

[Title of District Court and Cause.]

STATEMENT OF POINTS ON WHICH DEFENDANT-APPELLANT INTENDS TO RELY ON APPEAL

Comes now the Defendant-Appellant in the above entitled cause and, in accordance with Rule 75 (d) of the Federal Rules of Civil Procedure, states that on the appeal the following points will be relied on:

1. The District Court erred in adjudging United States Letters Patent 2,156,519 good and valid in law and particularly as to claims 1, 13, 14, 15 and 17 thereof.

2. The District Court erred in adjudging that the defendant Halliburton Oil Well Cementing Company has infringed United States Letters Patent 2,156,519, and particularly claims [37] 1, 13, 14, 15 and 17 thereof.

3. The District Court erred in finding that the claims of United States Letters Patent 2,156,519 define invention over the prior art.

4. The District Court erred in according United States Letters Patent 2,156,519 a broad range of equivalents, particularly after having found it to be merely an "improvement" patent.

5. The District Court erred in finding that an electrical filter circuit as part of an electrical sound recording system is the equivalent of a mechanical acoustically tuned resonator (a pipe of a particular length) as part of a mechanical recording system.

6. The District Court erred in not finding that the proceedings in the Patent Office estop Plaintiffs from asserting that an electrical filter circuit is the equivalent of an acoustically tuned resonator in the apparatus of United States Letters Patent 2,156,519.

7. The District Court erred in not finding that mechanical acoustically tuned resonators were old and well known in the art prior to United States Letters Patent 2,156,519 and that no invention

was involved in using an acoustically tuned resonator in known mechanical sound recording systems, particularly those of the claims of United States Letters Patent 2,156,519 in suit.

8. Having found that it was old in the art prior to United States Letters Patent 2,156,519 to fire a gun into a pipe and mechanically record the echo from an obstruction in the pipe, and having found that it was also old in the art to inject into a well casing a charge of gas from a cylinder of gas under pressure and record electrically the echoes from obstructions in the well, the District Court erred in finding that the apparatus of United States Letters Patent 2,156,519 differs from and is an improvement [38] over the prior art and particularly in finding that invention is involved in the incorporation into such old apparatus of tuned acoustical means (a pipe of a particular length).

9. The District Court erred in adjudging United States Reissue Letters Patent 21,383 good and valid in law as to each of the claims thereof.

10. The District Court erred in adjudging that defendant Halliburton Oil Well Cementing Company has infringed all or any of the claims of United States Letters Patent Reissue 21,383, and particularly that defendant Halliburton Oil Well Cementing Company should be enjoined from "using, practicing or selling or causing to be used, practiced or sold any method for determining pressure in the fluid column of a well, or determining density of the fluid in the fluid column in a well, or determining the production capacity, productivity

index or potential of a well which includes the steps of taking two gas pressure measurements and two corresponding fluid level measurements and comparing them".

11. The District Court erred in finding that the claims of United States Letters Patent Reissue 21,383 define inventions over the prior art.

12. The District Court erred in not finding that claims 1 to 8, inclusive, of United States Letters Patent Reissue 21,383 are limited to the determination of density of fluid and that any process which does not include the determination of density is not an infringement of said claims 1 to 8, inclusive.

13. The District Court erred in not finding that during the prosecution of the application for United States Letters Patent 2,161,733, (the original of Reissue 21,383) all the claims were intentionally and expressly limited to the determination of density and that claims not limited to the determination of density were cancelled and abandoned and that therefore claims 9, 10 and 11 of Reissue 21,383, must be interpreted as also limited to the [39] determination of density to save them from a holding of invalidity.

14. The District Court erred in not finding that the only novelty in United States Letters Patent Reissue 21,383 resides in the mental or mathematical steps of "dividing", "comparing", "determining", etc. which do not constitute patentable subject matter.

15. The District Court erred in not finding that Plaintiffs, by this action are attempting to assert a broad and dominating monopoly wholly unsupported by any alleged invention made by Cranford P. Walker, Plaintiff, and wholly unsupported by any alleged invention disclosed in United States Letters Patent 2,156,519 and Reissue 21,383, and in not finding that the commercial success enjoyed by Plaintiffs in their Depthograph business is due primarily to the inventions of the prior art and Plaintiffs' exploitation thereof, rather than to the alleged inventions of Patents 2,156,519 and Reissue 21,383 in suit.

FRANK L. A. GRAHAM,
EARL BABCOCK,
Attorneys for Defendant-Appellant.

Service of a copy of this Statement of Points on Which Defendant-Appellant Intends to Rely on Appeal, is hereby acknowledged.

HAROLD W. MATTINGLY,
Attorney for Plaintiffs-Appellees.

June 1, 1943.

[Endorsed]: Filed June 1, 1943. [40]

[Title of District Court and Cause.]

NOTICE OF APPEAL TO THE CIRCUIT COURT OF APPEALS

Notice is hereby given that Cranford P. Walker, and Cranford P. Walker, D. A. Walker, Robert P. Miller and Milo C. Ketchum, doing business as Depthograph Company, a copartnership, plaintiffs above named, hereby appeal to the Circuit Court of Appeals for the Ninth Circuit from that portion of the final judgment entered in this action on the 22nd day of April, 1943 which relates to the validity of United States Letters Patent No. 2,209,944, that portion being Paragraph IV of the Decree.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs

May 13, 1943.

[Endorsed]: Filed & Mailed copy F. L. A. Graham, Atty. for Deft. May 17, 1943 Edmund L. Smith, Clerk By Theodore Hocke, Deputy Clerk.

[41]

District Court of the United States
Southern District of California

Central Division

No. 1655-PH Civil

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY, a copartnership,

Plaintiffs and Cross-Appellants,

v.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Defendant and Cross-Appellee.

BOND ON APPEAL

Know All Men by These Presents that United States Fidelity and Guaranty Company, a corporation organized and existing under the laws of the State of Maryland, and duly licensed to transact business in the State of California, is held and firmly bound unto Halliburton Oil Well Cementing Company, a Delaware corporation, defendant and cross-appellee in the above entitled case, in the penal sum of Two Hundred Fifty and no/100ths ($250.00) Dollars, to be paid to said defendant and cross-appellee, its successors, assigns, or legal representatives, for which payment [42] well and truly to be made, the United States Fidelity and Guar-

anty Company binds itself, its successors and assigns firmly by these presents.

The Condition Of The Above Obligation Is Such, That Whereas, Cranford P. Walker, and Cranford P. Walker, D. A. Walker, Robert P. Miller and Milo C. Ketchum, doing business as Depthograph Company, the plaintiffs, are about to take an appeal to the United States Circuit Court of Appeals for the Ninth Circuit to reverse that portion of the judgment rendered and entered by the United States District Court for the Southern District of California, Central Division, in the above entitled case, on April 22, 1943, in favor of the defendant and cross-appellee, to-wit: Paragraph II of the Decree.

Now, Therefore, if the above named plaintiffs and cross-appellants shall prosecute said appeal to effect and answer all costs which may be adjudged against it if the appeal is dismissed, or the judgment affirmed, or such costs as the Appellate Court may award if the judgment is modified, then this obligation shall be void; otherwise to remain in full force and effect.

It Is Hereby Agreed by the Surety that in case of default or contumacy on the part of the Principal or Surety, the Court may, upon notice to them of not less than ten days, proceed summarily and render judgment against them, or either of them, in accordance with their obligation and award execution thereon.

Signed, sealed and dated this 17th day of May, 1943.

[Seal] UNITED STATES FIDELITY AND GUARANTY COMPANY

By C. D. BRICK
Attorney in Fact

Examined and recommended for approval as provided in Rule 13.

HAROLD W. MATTINGLY
Attorney for Plaintiffs and Cross-Appellants

State of California
County of Los Angeles—ss:

On this 17th day of May in the year one thousand nine hundred and forty-three, before me, Agnes L. Whyte a Notary Public in and for said County and State, residing therein, duly commissioned and sworn, personally appeared O. D. Brick, known to me to be the duly authorized Attorney-in-fact of the United States Fidelity and Guaranty Company, and the same person whose name is subscribed to the within instrument as the Attorney-in-fact of said Company and the said O. D. Brick duly acknowledged to me that he subscribed the name of the United States Fidelity and Guaranty Company thereto as Surety and his own name as Attorney-in-fact.

In Witness Whereof, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.

[Seal] AGNES L. WHYTE

Notary Public in and for Los Angeles County, State of California

My Commission Expires Feb. 26, 1945.

[Endorsed]: Filed May 17, 1943. [43]

District Court of the United States
Southern District of California

Central Division

No. 1655-PH Civil

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY,

Plaintiffs,

v.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Defendant

STATEMENT OF POINTS ON WHICH PLAINTIFFS AND CROSS-APPELLANTS INTEND TO RELY ON APPEAL

Come Now the plaintiffs and cross-appellants in the above entitled cause and, in accordance with

Rule 75(d) of the Federal Rules of Civil Procedure, state that on the appeal the following points will be relied on:

1. The District Court erred in adjudging United States Letters Patent 2,209,944 invalid.

2. The District Court erred in adjudging United States Letters Patent No. 2,209,944 invalid as to each of the claims thereof as defining methods which do not involve invention and are unpatentable. [44]

3. The District Court erred in failing to find that the claims of United States Letters Patent No. 2,209,944 and each of them define patentable invention over the prior art.

4. The District Court erred in failing to find that the claims of United States Letters Patent No. 2,209,944 and each of them define a patentable method comprising a series of physical steps to produce information from which the results described may be computed.

5. The District Court erred in failing to find that the only prior art submitted by the defendant pertaining to the questions of anticipation and lack of invention were the same prior art which had been considered by the United States Patent Office during the prosecution of the applications resulting in United States Letters Patent No. 2,209,944 and that said Letters Patent and each of the claims thereof define patentable invention over any of such prior art.

6. The District Court erred in failing to find that the invention set forth and claimed in United

States Letters Patent No. 2,209,944 was a very meritorious invention, constituted a distinct advance in the art to which it relates, solved successfully for the first time a problem on which others had made many attempts but had never succeeded and that said patent is entitled to a liberal interpretation.

7. The District Court erred in finding that "United States Letters Patent No. 2,209,944 is a method patent and discloses and claims certain methods of determining the locations of obstructions in a well by introducing into the well a pressure wave and the recording of echoes from the various known obstructions or partial obstructions in the well, and calculating from information so acquired the location of the obstructions. The novelty of this structure consists only in the performance of [45] mental steps such as "counting", "observing", "computing" and "comparing", which do not involve invention."

8. The District Court erred in failing to find that none of the prior art before the Court disclosed or taught the methods defined in the claims of United States Letters Patent No. 2,209,944.

9. The District Court erred in failing to find that the novelty in the methods defined in the claims of United States Letters Patent No. 2,209,944 is more than the mere performance of mental steps and does involve invention.

10. The District Court erred in failing to find that the defendant has infringed each and every of

the claims of United States Letters Patent No. 2,209,944.

11. The District Court erred in not awarding costs of suit to plaintiffs.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs and Cross-Appellants

Service of a copy of this Statement of Points on which Plaintiffs and Cross-Appellants Intend to Rely on Appeal is hereby acknowledged.

FRANK L. GRAHAM
EARL BABCOCK
Attorneys for Defendant and Cross-Appellee

[Endorsed]: Filed June 25, 1943. [46]

[Title of District Court and Cause.]

NARRATIVE STATEMENT OF TESTIMONY AND PROCEEDINGS IN DISTRICT COURT

The following is a statement of the testimony and proceedings in the District Court, part of which is in narrative and part in question and answer form.

Los Angeles, California
Tuesday, October 6, 1942
10:00 A. M.

Appearances:

Robert W. Fulwider, Esq., and
Harold W. Mattingly, Esq.
for plaintiffs.

Frank L. A. Graham, Esq.,
Earl Babcock, Esq., and
William R. Graham, Esq.,
for defendant.

During the opening statements at the trial, the following occurred:

Mr. Mattingly: At this time I would like to offer into evidence the three patents in issue, Nos. 2,156,519, Reissue 21,383, and 2,209,944, as the Plaintiffs' Exhibits 1, 2, and 3, respectively.

The Court: Any objection?

Mr. Graham: No.

The Court: In evidence.

[Printer's Note: Plaintiffs' Exhibits Nos. 1, 2, 3 are set out in full in the Book of Exhibits.]

Mr. Mattingly: And at this time I would like to offer into evidence the folder which was marked Exhibit 1, attached to the bill of particulars, as Plaintiffs' Exhibit 6. [48]

Mr. Frank L. A. Graham: Will you give that a name, please? "An echo writes the fluid level of your well."

Mr. Mattingly: Also attached to the Bill of Particulars was a single sheet advertisement or apparently a reprint of an advertisement put out by the Halliburton Oil Well Cementing Company, and marked Exhibit 2 in connection with the Bill of Particulars; and at this time I would like to offer that into evidence.

The Court: It will be No. 7. That will be the "Echo Meter" folder. Do you offer both sides of this Exhibit?

Mr. Mattingly: Yes, Your Honor.

The Court: All right.

[Printer's Note: Plaintiffs' Exhibits Nos. 6 and 7 are set out in full in the Book of Exhibits.]

Mr. Mattingly: Also attached to the Bill of Particulars were five sheets of records, four of those sheets bearing as a heading "Echo Meter Field Data Record"—and the largest of the sheets, the fifth sheet, bearing the title "Sub-Surface Pressure Test Data—Potential Determination for Pumping Wells." Each of these sheets also bears notation "Company Surf Associates Well State No. 1—Field Huntington Beach." Those sheets were attached to the bill of particulars.

The Court: All right. The four sheets will be numbered 8, 8A, B, C and D. And the long sheet, the "Central Committee" sheet, the long one which is: "Central Committee of Calif. Oil Producers, Office of Oil Umpire, 1160 Subway Terminal," shall we call that the "Central Committee" exhibit?

Call the other the "Halliburton Co. Echo-Meter Data" sheets 8A, B, C, D? [49]

The Clerk: That will be Plaintiffs' Exhibits "8A, B, C and D."

[Printer's Note: Plaintiffs' Exhibits Nos. 8A, 8B, 8C and 8D are set out in full in the Book of Exhibits.]

The Court: That is right; and No. 9 will be the "Central Committee Echo-Meter Field Data" from the same well, "State No. 1—Huntington Beach."

[Printer's Note: Plaintiffs' Exhibit No. 9 is set out in full in the Book of Exhibits.]

Mr. Mattingly: In this case, your Honor, we filed interrogatories on behalf of the plaintiffs and at this time I would like to offer into evidence interrogatories filed by plaintiffs and answers filed by the defendant thereto. May we have the Interrogatories admitted in evidence as Exhibit No. 10, and the Answers to the Interrogatories as Plaintiffs' Exhibit 11? And I offer the Supplemental Answer in evidence as Plaintiffs' Exhibit No. 12.

[Printer's Note: Plaintiffs' Exhibits Nos. 10, 11, and 12 are set out in the Book of Exhibits.]

The Court: The drawing marked Exhibit No. 4 attached to Plaintiffs' Interrogatories,—the Interrogatory number is 10,—call that 10A then.

[Printer's Note: Plaintiffs' Exhibit No. 10-A is set out in full in the Book of Exhibits.]

Mr. Mattingly: I offer in evidence as Plaintiffs' Exhibit 11A, Defendant's Exhibit No. 16 accompanying Defendant's Answers to Interrogatories; as Plaintiffs' Exhibit 11B, Defendant's Exhibit No. 17 accompanying Defendant's Answers to Interrogatories; as Plaintiffs' Exhibit 11C, Defendant's Exhibit No. 18 accompanying the Answers to Interrogatories. That Exhibit is an instruction book bound in brown. As Plaintiffs' Exhibit No. 12, the Supplemental Answer to Plaintiffs' Interrogatories; as Plaintiffs' Exhibit 12A, Defendant's Exhibit No. 19 attached to Supplemental Answers to Interrogatories; Plaintiffs' Exhibit No. 12-B, Defendant's Exhibit No. 20 attached to the supplemental answer to the [50] interrogatories; as Plaintiffs' Exhibit No. 12-C, Defendant's Exhibit No. 21 attached to the supplemental answer to the interrogatories; as Plaintiffs' Exhibit No. 12-D, Defendant's Exhibit No. 22 attached to the supplemental answer to the interrogatories; as Plaintiffs' Exhibit No. 12-E, Defendant's Exhibit No. 23 attached to the supplemental answer to the interrogatories.

[Printer's Note: Plaintiffs' Exhibits Nos. 11-A, 11-B, 11-C, 12-A, 12-B, 12-C, 12-D, and 12-E are set out in the Book of Exhibits.]

In addition to these pleadings that I have mentioned so far, the plaintiff and defendant have agreed on a stipulation as to certain facts with

regard to this case, and I offer in evidence the stipulation just referred to as Plaintiffs' Exhibit No. 13.

[Printer's Note: Plaintiffs Exhibit No. 13 is set out in full in the Book of Exhibits.]

That new drawing, with the corrections, is the drawing which is attached to our pre-trial brief, and I offer in evidence an enlargement of that drawing which was attached to the pre-trial brief, as Plaintiffs' Exhibit No. 14.

Mr. F. L. A. Graham: Your Honor, we would object to that being offered in evidence. If it is to be used as a true and correct showing of our device we would like some evidence on that. It is a drawing plaintiffs have made up apparently from the interrogatories. I would say, in general, it shows the general features of the device, but I don't know whether it corresponds or not.

The Court: I don't think it is evidence. It is argument. [51]

Mr. Mattingly: The reason I would like to offer that in evidence, your Honor, and I think it is evidence, is that the supplemental answer to interrogatory No. 14 refers to and enumerates various parts, identifies various parts of the defendant's apparatus, and then describes it by reference to some drawing.

Mr. F. L. A. Graham: If the court please, this drawing, of which that is a modification or revised edition, was made by the plaintiffs. It is not evidence, but just a drawing that counsel has had

made, and he has offered it in evidence without any proof of these things which are shown in the drawing. You can use that in argument.

The Court: I think that is correct. That is argument. It is here, but it is not evidence unless you lay a foundation and identify it.

Mr. Mattingly: Then may we have that enlarged drawing marked for identification?

The Court: All right.

The Clerk: Plaintiffs' 14 for identification.

The Court: That is a drawing of what?

Mr. Mattingly: A diagrammatic drawing of the defendant's apparatus.

The Court: Is it the defendant's apparatus?

Mr. Mattingly: Yes.

The Court: A drawing of the defendant's apparatus?

Mr. Mattingly: We might refer to that as a drawing illustrating defendant's answer and supplemental answer to interro- [52] gatory No. 14.

The Court: It is offered for identification as a drawing of defendant's apparatus, is that correct?

Mr. Mattingly: Yes.

Mr. F. L. A. Graham: Put it this way: Plaintiffs' illustrative drawing of defendant's apparatus.

The Court: I have it in my notes that it is plaintiffs' idea of defendant's apparatus.

Mr. Frank L. A. Graham: May I interrupt, your Honor? May I ask counsel if the filter, for instance, such as used by defendant is not used, why, then you do not claim infringement?

Mr. Mattingly: That is correct in so far as patent -519 is concerned, unless the defendant uses some other means for accenting the tubing collar echoes.

Mr. Frank L. A. Graham: Counsel is familiar with our apparatus and he has described it as having a filter in it. Now, I ask counsel if he will take the position at this time, if we do not use the filter do we infringe patent -519? I think that is a fair question.

Mr. Mattingly: If in your electrical system you do not use any other device which would act like or perform the same function of selecting out these particular echoes, I believe we would be willing to stipulate that there would be no infringement. I can make that, perhaps, clearer this way: That as long as the defendant does not in its system use any means especially adapted to [53] accenting the tubing collar echoes there would be no infringement of patent '519.

The Court: None at all? '519 is the mechanical apparatus.

Mr. Mattingly: That is correct.

The Court: If he does not use the filter or tuning device, that is, a device calculated to catch these tuning joints with regularity, then you claim no infringement of '519?

Mr. Mattingly: That is right.

The Court: You claim then, only infringement of the method?

Mr. Mattingly: That is right, because in the

method patent '944 we are not limited in our claims there to any tuning.

The Court: Let me go back again a minute now. That being the case, it is your position that the firing of the shell into the well, the electrical microphone and the tape, the recording apparatus, is not an infringement of '519?

Mr. Mattingly: That is correct. There must be that additional element, something which accents the tubing collar echoes associated with those other two devices. The reason I hesitate to stipulate——

The Court: You do think that firing with that shell, the use of the electrical microphone and the gas cooling its elements and recording the vibrations or creating the oscillation does violate—what is the method patent?

Mr. Mattingly: '944.

The Court: —'944?

Mr. Mattingly: That is right. [54]

The Court: I don't know. I can't see it. No doubt it is clear to everybody else in the court room, but it is not clear to me. You contend that the use of the electric filtering system is a violation of your rights to record with regularity the echoes produced from the joints, even though your patent is on a mechanical tuning sytem, and you do not contend that the projection of sound into the well by shot and the recording of it on an electrical microphone is a violation of your rights under the mechanical patent of your sound vibrating mechanically a diaphragm and recording it, instead of an electrical microphone and the introduction of the gas?

Mr. Mattingly: That is correct. Perhaps I can clear that for your Honor this way: That our mechanical patent represents one invention which was presented to the Patent Office and on which the patent was granted; and that invention is expressed in terms of the three elements in combination with each other.

The Court: Yes; three instrumentalities.

Mr. Mattingly: That is right.

The Court: One that introduces sound——

Mr. Mattingly: If the defendant omits one of those instrumentalities, then he does not infringe a claim which has been granted on a three-element combination.

The Court: Oh. It is essential to your mechanical patent '519, for anybody to infringe it, that he use all three of them?

Mr. Mattingly: That is correct. [55]

The Court: The reason, then, that he does not violate '519 by the introduction of the shell and the use of the diaphragm is because he does not use—assuming that he does not—he does not use the tuning device?

Mr. Mattingly: That is correct.

The Court: But if he brought in one of the others and used the tuning device he still would not be violating it, is that right?

Mr. Mattingly: He still would not be violating it, because in order to infringe that patent he must use all three elements. Now, if he does not produce sound and does not have any means for producing a sound in the well, then he would not in-

fringe the claim. If he does not use any means for recording or registering or otherwise recognizing that set of echoes when they come back, he would not infringe; and likewise, if he does not use the filter.

On behalf of the Defendant the following exhibits were offered and received in evidence:

Exhibit A—Certified copy of file wrapper and contents of abandoned application of Cranford P. Walker, Serial No. 270,865 filed Apr. 29, 1939.

Exhibit B—Certified copy of file wrapper and contents of application filed [56] Sept. 25, 1939, which resulted in Patent No. 2,209,944 in suit.

[Printer's Note: Defendant's Exhibits A and B are set out in full in the Book of Exhibits.]

MALCOLM WELLS MORRIS

a witness called by Plaintiffs, testified as follows:

Direct Examination

My business address is Standard Oil Company, Standard Oil Building, Los Angeles. I have been employed by the Standard Oil Company since 1929 as a production engineer. I was located in Taft, Kern County oil fields from 1929 to 1939; 1939 to the present date, Los Angeles, dealing with the Los Angeles Basin [57] and Coastal oil fields. My production engineering work is concerned with the engineering features of efficiently producing oil from the ground, working with the production super-

(Testimony of Malcolm Wells Morris.)

intendents, production foremen of various fields. In the course of my duties I kept abreast of the times as to any developments in my department by reading technical publications, attending meetings of technical oil societies, discussion with other engineers and oil men. I have been an officer in the American Petroleum Institute continuously since 1930, that is, from 1930 to 1939, in the San Joaquin Valley Chapter of the American Petroleum Institute; 1939-1940 in the Long Beach Chapter as member of the drilling and production practice committee. It is a national committee of the American Petroleum Institute—in 1938, 1939, 1941 and this year. January 8th to August 1st of this year I served on the engineering sub-committee, the District Five Production Committee, making a survey of the oil reservoirs of the State, the way they should be produced and how much oil we could expect to obtain.

I am familiar with the measuring of sub-surface pressures and the acquiring of other data which you might call sub-surface data in oil wells. I started working on that when I first came to Standard Oil Company in 1929. I was co-author of a paper entitled "Use of Depth Pressure Data in Determination of Well Potentials in California" which was presented at the mid-year meeting of the American Petroleum Institute at Tulsa in May, 1941, and was published in the 1941 volume of Drilling and Production Practice, and another publication of the American Petroleum [58] Institute. The

(Testimony of Malcolm Wells Morris.)

nature of my early work in this field, that is, the sub-surface pressure measurement, was in helping the development of the depth pressure recorder, which the Standard Oil Company of California was able to develop and work out successfully. A depth pressure recorder which is used by the Standard Oil Company of California is an instrument which is used to measure pressures in an oil well. It is lowered into the oil well on a steel line, similar to piano wire. Shots are made at intervals as desired, and pressure recordings obtained. The instrument is 1¼ inches in diameter by 5 feet long. The pressure is recorded by a stylus on a chart drum which is turned by a clock. The oil pressure acts on the piston which travels through a packing gland, in order to keep oil out of the instrument. This instrument is attached to a rod which works against a spring in tension. The characteristics of the spring are determined so that one inch of travel represents so much pressure.

Prior to 1936 it was recognized as being necessary to secure sub-surface pressure and other sub-surface data. In 1929 our company was actively engaged in attempting to develop an instrument which would permit us to measure pressures in an oil well.

The depth pressure recorder can be used to measure pressures in a pumping well. We employed it for the measurement of the pressures in a pumping well by attaching the instrument below the pump. In that case we used a clock, which oper-

(Testimony of Malcolm Wells Morris.)

ates [59] from 5 to 8 days, and could obtain a record of pressure changes in the well during that period. In order to install it you have to take the pump out. Our instrument is sufficiently small so we can ordinarily install it without having to remove the tubing in a pumping well.

In explanation as to why a knowledge of sub-surface pressure is desirable, I will say that an oil man is handicapped by the fact that he never sees his work bench, and sub-surface pressure information gives knowledge as to the characteristics of the oil zone that you are attempting to exploit, and of the particular well which opens the zone. It gives information of importance, such as static pressure, which represents the pressure in the zone when you are not removing a fluid; and the producing pressure, which is a pressure which is determined at a desired rate of production.

The fluid level measurement is an old art in the oil industry under static conditions. It represents the first approach or attempt to determine pressures in the reservoir when fluids are not being withdrawn. In the Standard Oil Company of California it is standard procedure, whenever pumping equipment is removed from the well, to run a bailer in on the sand line, and determine the position of the fluid in the hole. We were not able to determine the position of the fluid in the hole with the well pumping, and we had no equipment that we could run down between the tubing and the casing of the well. [60] Also, it was customary

(Testimony of Malcolm Wells Morris.)

practice to use a catcher set on the tubing, which would be an obstacle, which would prevent the passage of any instrument which you might try to lower in the well under producing conditions.

I have heard of some attempts being made to measure fluid between the tubing and the casing by means of floats or equipment run in on the line.

By Mr. Fulwider:

Q. Is it desirable, or was it recognized prior to 1936, as being desirable to know the density or gradient of the fluid in the well?

A. With the development of a satisfactory pressure recorder we were able to determine the density or gradient under producing or shut-in static conditions in flowing wells, and that information proved to be of great benefit to us in our operations. With our depth pressure recorder installed below the pump in pumping wells we were able to measure pressure below the pump with the well producing or shut in. However, we were not able to determine the gradient. I personally felt that a knowledge of gradients under pumping conditions would be quite illuminating and helpful.

The Court: What do you mean by "gradient" —pressure?

A. Gradient is the pressure in terms of depth pounds per hundred feet expressed by a column of oil, water or gas. [61]

By Mr. Fulwider:

Q. That is really synonymous with density?

(Testimony of Malcolm Wells Morris.)

A. That is correct.

Q. How about well potentials or capacities?

A. We calculated, starting in 1931, well capacities of flowing wells. It was a regular operation. We, to a lesser degree, calculated the same type of information in our pumping wells by installing a recorder below the pump.

The Court: Did you keep the recorder there all the time?

A. No, sir, we took the measurement and removed it. Our first instrument had to be installed on the tubing; we had to remove the rods, pump and tubing.

Prior to 1936, to my knowledge there was not any apparatus available to the oil industry for determining producing fluid levels or density in pumping wells. The pressure recorder yielded measurement on the pressure, but gave no information as to density of pumping wells or levels under pumping conditions. Under static conditions we could obtain density and fluid level. And, so far I know, there was no other apparatus on the market or method by which you could obtain these determinations.

I am acquainted with Mr. Cranford P. Walker, and am also acquainted with his depthograph methods and equipment. I first became acquainted with Mr. Walker on May 1st, 1936. I received a call from the production engineer at Kettleman, who advised [62] that Mr. Walker had made a demonstration

(Testimony of Malcolm Wells Morris.)

on a Standard Oil Company well in the Coalinga field that morning and was driving down into Taft that afternoon and would make a free demonstration for us if we desired. Mr. Walker came in the office that afternoon and introduced himself. He explained briefly the type of information that he could develop and the principles of his method. I had arranged for a demonstration at well No. 218, Section 33-D, Lake View area. That is situated a few miles from Taft.

By Mr. Fulwider:

Q. Did Mr. Walker put on that demonstration that you had arranged for?

A. Yes. He hooked up his apparatus to the casing head on the well and made a graph of the showing of fluid level, the echo from the fluid level in the well, with the well pumping. I witnessed the tests, as well as several other members of the production staff. In the method he then used, he hooked up his recording instrument, introduced a charge of high-pressure gas into the casing head of the well, recorded the time that was required from the time the gas was released into the casing head of the well until it went to the fluid level and was returned to the casing head.

We didn't attempt to determine fluid level on this demonstration. It was getting late in the evening and the fluid level was above the tubing catcher in the well. There was no way of determining the depth of the fluid level. [63]

(Testimony of Malcolm Wells Morris.)

We simply had the picture and record of the number of seconds it took for this pressure wave to travel from the casing head to the fluid and return. He explained that he had an instrument, a calibration tube, which he could hook up and could estimate the rate of travel of the pressure wave in this particular well. As I said, it was getting late and we were not interested at the time, sufficiently interested at the moment to wait around while he did this additional work. This was simply a qualitative demonstration that showed that he could measure the time for this echo to go from the well head to the fluid and return. It was one echo. We felt the fluid must be above the catcher, because if it had been below the catcher we would have expected to have gotten an echo from the catcher and from the fluid.

Later work verified that, but it was not verified on that particular well. This is simply an account of the first time I saw the instrument and the first time it was used in my presence. My reaction was that I was interested in the possibilities of the instrument, but I was skeptical, or I wanted to be shown that it was of sufficient accuracy to make it usable for helping us in solving our problems. Prior to that, I had heard talk among the industry that such an instrument was available, but I had no first hand knowledge as to its accuracy. [64]

I requested Mr. Walker to return at his convenience for a further discussion regarding the equipment. He came in the office the following day, that

(Testimony of Malcolm Wells Morris.)

is, May 2nd, 1936, and explained the work that he had done and what he thought he could accomplish, in more detail than we had had time to review it the preceding afternoon. He explained that there were two methods by which he could evaluate the position of fluid level, namely through the use of a calibration tube. This was a measured section of pipe which was set up at the surface near the well, gas from the well was introduced from the tube and velocity of travel of pressure wave in the well gas was determined under surface conditions. From that an estimate was made as to what the velocity of travel of the pressure wave would be in the well. I was quite skeptical as to the absolute accuracy of that method.

The second method was to use the velocity indicated in the well by reflection from a known obstacle, which might be a tubing catcher or possibly a top of a smaller size of casing, a liner top, where the depth to that obstacle was known. Using the velocity calculated from that depth and the time for the echo to go from the surface to the obstacle and return, and the time from the surface to the level and return, you could calculate the position of the fluid level. I was dubious as to [65] whether the velocity of the wave in the well would be sufficiently constant that you could secure accurate results by extrapolating deeper into the earth from the velocity indicated in the upper portion of the hole.

(Testimony of Malcolm Wells Morris.)

Mr. Walker offered to make free tests if we would supply the wells, would cooperate by supplying the wells. This offer was approved by the management and we made arrangements for tests that we thought would prove or disprove what the instrument was good for. As wells were pulled for repairs to the pump, we installed obstacles, reflection points on the outside of the tubing at variable intervals above the tubing catcher. The position of these reflectors was measured by the company and recorded. From two to four additional obstruction points or reflectors were installed on the tubing in the seven wells that were selected for the tests. The test work was started on May 14, 1936, and extended over a period of several weeks. The position of the top reflector, the depth to the top reflector, was supplied to Mr. Walker, and he was requested to determine the position of the other reflection points in the well and advise us as to the depth, and to give us copies of the graphs so that we could check his determinations. Repeated tests were conducted at the seven wells under the different varying conditions of surface pressure and production. The data were [66] analyzed for errors which could be attributed to unfaithful recording, interpretation of charts—that is, the personal element, whether one man would measure the chart the same as another man—and third, as to whether the velocity of the wave changed sufficiently in the well so as to introduce errors through extrapolating from high reflection points to lower ones.

(Testimony of Malcolm Wells Morris.)

Q. What method did he use in computing the unknown locations of the reflectors in those tests?

A. The velocity of the pressure wave to the top reflection point was calculated from the depth measurement to the point we had supplied Mr. Walker and the time which was recorded on the graph. We checked all of his determinations. Then he took the time to the lower reflection points and, with the velocity determined from the upper known point, calculated the depth of the lower points.

By the Court: Was he accurate?

A. We analyzed 127 runs and came to the conclusion that the average deviation in those tests was six feet, which was sufficiently accurate for our purposes. For example, he calculated the position of reflector point 3000 feet, and on the average he was within six feet of that depth.

By Mr. Fulwider:

Q. His method, then, in general constituted comparing of the time space on the chart of the known to the time space on the chart of the unknown?

A. That is correct. For example, we possibly installed [67] the first reflectors at 2000 feet. The depths were random depths. We deliberately mixed them up so that there was no sequence there that he could use in getting the answer. But the known reflection point was approximately 2000 feet. We might have installed the next reflection point at possibly close to 2400 feet, another one at possibly 2600 feet, and another one at 2750, on the same well. And Mr. Walker was given the depth of the top

(Testimony of Malcolm Wells Morris.)

point. He was requested to supply us with information as to what he calculated the positions were of these other reflection points; and, for example, if this lowest reflector were at 2750 his average error was six feet.

We took the charts which he submitted and further analyzed them, and using the top reflector and recalculating the position of the others, using the next to the top reflector and calculating the top and the lower reflectors, and took the third reflector and calculated those, and took the fourth and calculated the others. We could calculate up or down, either way. He was unable to do that, as we never supplied him the depth of the other reflectors. The shorter the extrapolation the greater accuracy. Extrapolation there means distance from the known point to the unknown, in a straight line.

Q. Did he subsequently do any commercial tests for you?

A. We requested him to measure the fluid level in four [68] wells in Mountain View. The work was done between August 7th and August 11th, 1936. This was paid work.

Mr. Frank L. A. Graham: Just a minute. If your Honor please, we object to any testimony about these, unless we know that the apparatus used was the apparatus of the patent. We don't know what that was.

The Court: Well, I don't know how we are going to find out until we get a chance to have the witness tell us.

(Testimony of Malcolm Wells Morris.)

By Mr. Fulwider:

Q. What apparatus and method did Walker use on those tests?

A. The method that was used on the test was to close in the casing head of the wells and the pressure, surface pressure, was permitted to build up to the maximum at which time Mr. Walker connected up his equipment and introduced a pressure wave. Do you want to go all through that again?

The Court: Well, he wants to know what he did, if he used his equipment. Did he have all his gadgets there?

A. Well——

Q. You don't know whether he had all of them. All right.

A. I am not familiar with the patent so far. I have never gone into that particular.

Q. You said he connected his equipment.

A. Well, he took and measured that fluid level for us by [69] this equipment. He introduced the pressure wave—and we could go all through that.

Q. Go ahead and tell us what he did.

By Mr. Fulwider:

Go ahead.

A. Introduced the pressure wave into the well, measured the time required for the pressure wave to go to the fluid level and return. The depth to the fluid level was calculated from a reflection point which was above the fluid, which we knew the depth to the reflection point.

(Testimony of Malcolm Wells Morris.)

By the Court: Had you installed a special reflector?

A. Yes, sir; we had a reflector installed there. It was a tubing catcher in this case. The fluid level was above the pump in these wells, and we estimated the pressure at the pump by assuming that the liquid fluid in the well was of tank oil density, corrected for the temperatures at the bottom of the well.

Q. In these tests at Mountain View, or prior tests that you have mentioned, what was the nature of the curve of the graph between the shot point at the top and the first major reflection either from the known or unknown.

A. It was an erratic line with small jiggles, and in general simulated a sine curve. That is, it had a shape such as that.

Q. Was there sufficient regularity to it, or did it have any characteristics which would enable you to distinguish what [70] those peaks meant?

A. We had no knowledge of what those peaks meant.

Q. In this early test, the only portions of the graph that you used were the major reflections which showed up clearly?

A. Fluid level reflections, or any reflection from a point above any obstacle.

Q. Such as tubing catchers, or reflectors that you put in?

A. That's right. To calculate the pressure at the pump, we closed the casing heads up and al-

(Testimony of Malcolm Wells Morris.)

lowed pressures to build up to maximum before taking a measurement of the fluid level, in order to get the gas column as close to the pump as we could. We knew how to determine the pressure increment in the gas column, but were uncertain as to what the gradient would be between the top of the fluid level and the pump. We did not have any certain knowledge at that time, so, in order to minimize the effect of that uncertainty, we forced the fluid as low as we could with the means that were available at the well.

We were interested in using the Depthograph method at these wells to determine two things: First, whether or not we were obtaining the maximum amount of oil from the well. These wells were located in a highly competitive producing area, and we wished to get every barrel possible out of them. In case the wells were not being pumped off; in case we were not obtaining the maximum amount of oil that the wells were capable of [71] yielding, we wished to get an idea of how much more oil might be available, from measurements made through the area with our depth pressure recorder.

When the wells were on flowing or gas lifting we had what we felt were reasonably good estimates of what the static pressures were in the oil sand when we were not producing oil. It as recognized procedure to determine the pressure in the oil sand of those producing, and from the static pressure and producing pressure to calculate the

(Testimony of Malcolm Wells Morris.)

productivity index; that is, the number of barrels per day of oil obtained for every pound that produced pressure below the static.

To determine the fluid level at these wells, it can be likened to a qualitative measurement, possibly on the order of where you put your hand on your child's brow. You find it is hot; you have a qualitative idea that he is possibly sick. By using a thermometer you obtain a quantitative determination of what the fever is. If the wells were not pumping off we wished to get as accurate an idea as possible of what the producing pressures were in the wells.

By the Court: The producing pressure—bottom hole pressure?

A. Bottom hole pressure, yes; the pressure against the oil sand. We could approach that by using the surface pressure, which we measured with a test gauge, by computing the increase in weight between the surface and the fluid level, due to the gas column weight; but it was necessary to estimate the amount [72] of pressure represented by the length of fluid between the pump and the fluid level.

By the Court: You assumed the fluid level?

A. We assumed that the fluid level was dense oil, at that time, but I was uncertain about that. That was purely an assumption, and in order to minimize the error, if that assumption were erroneous, I stipulated that we could drive the fluid as close to the pump as we could and thereby minimize

(Testimony of Malcolm Wells Morris.)

the estimate that we had to make for the pressure increment between the fluid and the pump.

By Mr. Fulwider:

Q. That is, the gravity of the oil in the tank which you could measure was only an approximation of the gravity of the oil down at the pump, is that correct? You were assuming that they were the same for the purpose of that calculation?

A. At that time I was of the opinion that fluid near the pump was oil.

By the Court: I think I understand. In other words, you could measure the density of gas, but you could not measure the density of the fluid, because you did not know what the fluid was?

A. That is correct.

By the Court: You were assuming if you knew it was all oil you could measure the density? [73]

A. That is correct.

By the Court: Therefore you wanted to eliminate the unknown quantity, to-wit, the fluid?

A. From the considerable amount of work that we had done with the depth pressure recorder in flowing wells we had a good knowledge as to gradients and flow tube under producing conditions, and that had raised uncertainty in my mind as to what the gradients of the fluid might be between the tubing and the casing in a pumping well under producing conditions. While this assumption that I made in calculating the pressure of the pump was logical I was uncertain of it, and I tried to mini-

(Testimony of Malcolm Wells Morris.)

mize the error that would be induced if I was wrong, by driving the fluid as close to the pump as possible.

By the Court: The purpose of these tests at the Mountain View field was to ascertain the bottom hole pressure? Was that the ultimate thing you wanted to find out?

A. There were two purposes: to determine whether or not we were getting all the oil from the wells that the wells were capable of yielding. This was a highly competitive producing area, and we wanted to get the oil before our neighbors got it. Secondly, if the wells were not pumping off; if we were not getting all the oil available, to get an estimate of how much more oil we might be able to obtain.

By the Court: By obtaining the bottom hole pressure? [74]

A. Yes. We know the static pressure. By ascertaining the producing bottom hole pressure we could calculate how many more barrels of oil per day we could obtain from the well. That would permit us to plan on what change of equipment we might have to make in order to get the additional oil, and to work out the economics of the change. We could not afford to spend a thousand dollars to get only five barrels a day more oil. Both of those results were calculated from the fluid level.

By the Court: The bottom hole pressure is ascertained from the fluid level?

(Testimony of Malcolm Wells Morris.)

A. We were estimating the bottom hole pressure from a single fiuid level measurement.

By Mr. Fulwider:

Q. You have described the method that you used in the Mountain View test. I wonder if you will, in a few words, describe the apparatus that Mr. Walker used to make this determination in the Mountain View field, in response to Mr. Graham's query.

By Mr. Graham: I would prefer that the witness testify as to what he saw there. This is a very interesting point, and I want to know.

By Mr. Fulwider:

Q. Just describe as best you can the type of apparatus Walker employed.

By the Court: Have you seen his apparatus since?

A. My goodness, yes. It all looks the same though; it is always inside of the box. [75]

By Mr. Graham: May I ask what these notes are he is referring to now?

The Witness: This is the report which was prepared under my supervision, under date of May 10th, 1937, entitled: "Depthograph Equipment and Its Operation."

By Mr. Graham: Your Honor, that report is dated May, 1937; the Depthograph and its operation. What does that describe?

A. It describes something that was seen and reported on after these tests in 1936.

Q. What was that description taken from, do you know?

(Testimony of Malcolm Wells Morris.)

A. It was taken from our engineer, who was following these tests. It is his description of the apparatus.

By Mr. Graham: Then you don't know of your own knowledge, the description that your engineer has made, whether it applies to something in 1936 or 1937?

A. This description, to my knowledge, is the same as the apparatus that was used all through that period.

By Mr. Graham: There was no change in the apparatus?

A. I am interested in the apparatus as a service. We tested their method; their equipment; we fould it could do certain things which we considered would be satisfactory, and we commissioned them to do certain work for us. We watched the work to be sure they were using the equipment or the method which we had checked. We did not ask them to take their apparatus apart each time. [76]

By the Court: What you are saying is you don't know whether there was any change or improvement?

A. There was no change to my knowledge in the apparatus being used for this single shot work.

By the Court: Tell us what the equipment looked like in 1936.

By Mr. Graham: I want to know what he saw in 1936.

By Mr. Fulwider: We have an apparatus here in court as to what is being used now. We can

(Testimony of Malcolm Wells Morris.)

mark it for identification for the purpose of discussion, and let him point out any differences, and describe them.

By Mr. Graham: This man is an engineer. He went there particularly, and had these tests made. If he was not interested enough in the apparatus used to see the different parts of the apparatus, and how it worked, all this testimony is of no account. I want to know what this witness saw at that time.

By Mr. Fulwider: I was trying to save time.

By Mr. Graham: I don't want him to look at the apparatus which is made now, and testify from that.

By Mr. Fulwider: Describe then, in your won words, without the benefit of drawings or physical exhibits, what the apparatus was that you saw used in the Mountain View tests.

A. The apparatus that I saw used consisted of a supply of high-pressure gas, which was bottled. It was in a sealed [77] bottle of the type that is used, containing oxygen and acetylene, for welding purposes. That was connected into a piping arrangement from the casing head of the well to the recording equipment. Between the pressure connection and the recording equipment there was a quick closing valve of a large diameter, the opening in it being approximately the diameter of the piping. Two-inch piping was what was customarily employed. Around the quick closing valve was a by-pass of small piping, approximately a quarter of an inch, with a needle valve. Beyond this piping was the recording device, which consisted of a ground

(Testimony of Malcolm Wells Morris.)

glass in which you could get a reflection of light, which gave the indication of the return of the pressure wave from the obstacle; and inside of the equipment was a recording device for taking a photograph of those slight impulses.

By the Court: This was not a stylus?

A. No. The tuning fork arrangement was used to control the timing of the apparatus. That was used after the first preliminary testing work. The original timing was not satisfactory. It depended on the cycles of the Edison Company's light circuit, and it was not of sufficient accuracy, and that was changed early in May, and our subsequent work was then done with the tuning fork controlled [78] timing. The echo impinged on the diaphragm, which operated the mirror, so as to throw a light on the ground glass so that you could see it. This threw the light on a sensitive tape to photograph the path of the light. The by-pass around the large valve was for the purpose of keeping the impact of the pressure wave off of the diaphragm when it was first introduced into the well head.

By Mr. Fulwider:

Q. What equipment you have described, was that used by Mr. Walker on all of these tests about which you have testified?

A. That is correct.

Q. The method of operating that equipment, will you describe that just briefly?

A. The technique was to introduce a charge of

(Testimony of Malcolm Wells Morris.)

gas from the pressure bottle into the piping around the casing head with the by-pass valve open. Immediately after the pressure charge was introduced into the well, the main valve was opened. The film recorded the travel of the wave down the oil well to the fluid level and return, after which the apparatus was shut off. In the early test we were interested in the velocity changes in the wells, and we took as many as two or three complete recordings of the travel waves from the casing head to the fluid and return; to see if there were any indications of changes of velocity.

Q. Do you recall any tests made the latter part of [79] December, 1936, which were of particular significance, or otherwise?

A. The company requested the testing of three wells at Mountain View, and a well at Poso Creek. The test at Abadie No. 1, at Mountain View, was the first test to my knowledge where a measurement was taken of fluid gradients.

By the Court: Different people use the phrase "to my knowledge" in a different sense. Some of them use it in a sense that they know absolutely, and others use it in a sense of so far as their knowledge is concerned. How do you use it? You say that was the first test to your knowledge. Do you mean you know that was the first time?

A. I mean it in the sense that that was the first test I was aware of or familiar with, where we obtained a measurement and a determination of fluid gradients in the annulus between the tubing and

(Testimony of Malcolm Wells Morris.)

the casing, with the well pumping. That was Abadie No. 1, at Mountain View, starting December 29th, 1936, and was concluded December 31st, 1936.

In this test at Abadie No. 1, the pressure was built up from about 40 pounds at the surface to about 340 pounds. The well produced a small amount of gas, and the pressure built up very slowly, requiring about 48 hours to build up that amount. The operator of the Depthograph equipment observed the fluid level as the pressure built up; and Mr. Walker submitted data to us in a graph form of a plot of depth versus gas pressure—depth against gas pressure. Depth is the ordinate and the [80] gas pressure is the abscissa. The data plotted was substantially a straight line with a fluid density of 18.6 pounds per hundred feet. The solid oil density was approximately twice that. The fluid was moved from a position about 16 feet above the pump down to the pump inlet. That straight line indicated that the fluid density was constant, on the original position of the fluid level, with our operating casing pressure of about 40 pounds, down to pump.

Q. Was that a new idea to you at that time?

A. It came as very much of a shock to me.

Q. Had Mr. Walker ever told you anything about that, or propounded that relationship as a theory to you prior to that time?

A. I don't recall that he had. If he had produced any convincing evidence that this relationship existed I would not have been surprised at the

(Testimony of Malcolm Wells Morris.)

determination in our well. This measurement completely changed my conception regarding conditions in pumping wells. My conception prior to that was that there was a light froth near the top of the operating fluid level in a pumping well, and with depth down near the oil sand the oil was practically gas free; substantially solid oil. It was on that basis that I had previously estimated pressures, on our entire determinations, in August and subsequent months, as to what the operating pressures were at the pump. [81]

By Mr. Fulwider:

Q. Was there any one in your organization who had shared your previous view as to the density of the fluid?

By the Court: Was that the general conception in the industry?

A. I am not qualified to speak for the industry. It was, in our organization, your Honor. Those determinations completely revised our conception regarding conditions in these pumping wells.

By the Court: You were not familiar with the general conception that men had, who occupied the same position in other oil companies?

A. I have discussed the problem with them.

By the Court: Concerning the characteristics of that fluid was their conception of it the same, or approximately the same, as yours?

A. It was.

(Testimony of Malcolm Wells Morris.)

By Mr. Fulwider:

Q. You mentioned that Mr. Walker ran some Depthograph tests at Poso Creek, with the same equipment that you have described; can you tell me the nature of those tests, and anything of interest in connection with them?

A. That test was of interest, because we obtained only a single reflection in this well, which indicated that the fluid level was above the tubing catcher and the measured reflection point which we had placed on the tubing in the well [82] above the tubing catcher. The chart that was obtained had a series of echoes, which Mr. Walker said represented reflection from the tubing collars, and the tubing collars were counted, and from the measurements of tubing string we calculated the position of the fluid level.

By the Court: Was that verified as to each one from the tubing collars?

A. We verified them subsequently. At the moment we were interested in the fact that the fluid level was not below our measured reflection points. We found it was up in the hole. We proceeded to make a change in the apparatus to get more oil from the well. Our interest in this was that we always were working to get more oil. We were not worried so much from their side of it.

By Mr. Fulwider:

Q. You say Mr. Walker counted the echoes which represented tubing collars?

(Testimony of Malcolm Wells Morris.)

A. He said that the echoes did represent the tubing collars.

By Mr. F. L. A. Graham: What was the date of that?

By Mr. Fulwider: That was also in December, 1936. What was your opinion of it?

A. I knew if these were actual reflections from the tubing collars the maximum error would be less than one joint or length of tubing, or, in the case of that particular well, 20 feet. We would have a reflection from the last tubing collar above the fluid, and we could estimate from the time scale approximately [83] how much fluid would be below the bottom collar reflection; so that at the worst our error would be inside of 20 feet.

Q. You mentioned that you subsequently verified the accuracy of that method. Where were those tests run?

A. Those tests were run in several wells; some in the Taft area, where we had reflections, measured reflection points in the wells. We checked the tubing collar count against the number of joints of tubing, the reflection points, and found that the echoes were representative of the tubing collars. We had a record of the number of joints of tubing above and between the reflection points. My company is still using the Depthograph system and apparatus. We have used it at intervals as required since we first began using it commercially in 1936. Our company is completely satisfied with it; with the result of its

(Testimony of Malcolm Wells Morris.)

accuracy. We would not continue using it if we were not.

Q. Mr. Morris, I don't believe we covered the question of when the Standard Oil Company accepted this collar-counting method as a commercially useful or acceptable method to them. Could you tell us when that happened?

A. February, 1937, during some tests that were made in the Lake View area charts were obtained which had collar reflections on them at well 17; and we had three reflection points whose depths were known in this well. We were able to count the echoes and check it against the number of collars we knew to be in the tubing string above the first reflector and between the [84] various reflectors, and that checked out so that the method was accepted and we first put it to commercial use on our wells, at least, the method was used commercially on our wells first in March, 1937, during a series of tests of nine wells at Mountain View, Abadie No. 1 was retested and Wilson No. 2. These records were accepted as correct. The Depthograph tuned collars deliberately in these tests and the pressures were calculated from the graphs.

They tuned collars by using a length of pipe between the instrument and the casing head, which was about one-third of the distance between collars in the tubing string. That yielded the desired collar echo.

By the Court: What is the length of the tubing?

A. There are two standards which are common-

(Testimony of Malcolm Wells Morris.)

ly employed by our company. One range of tubing averages a little over 20 feet to the joint and the other range averages about 30 feet.

By Mr. Fulwider:

Q. You used the word "tuning." Does that mean tuning collars? Or did you mean accenting the collar echoes?

A. That is correct.

Q. So that they are distinguishable on the graph that you got?

A. Yes. This commercial tuning or accenting of the collar echoes on these later tests was started between March 10th and [85] 15th, 1937. Prior to that date the Depthograph obtained charts showing collar echoes, but they were not doing that deliberately, to my knowledge at least.

Q. And those earlier charts, if I understand it correctly, you were not positive whether they were collar echoes or not?

A. The first chart I saw, in December, 1936, at well 5, in section 5, was represented by Mr. Walker as showing collar echoes. We had no information available with which to check that claim. We obtained information and verified it in February of 1937.

Q. Then, after further proof, in March the company agreed that reports based on that method would be accepted?

A. We requested that he do that henceforth so that we would not have to go to the expense of in-

(Testimony of Malcolm Wells Morris.)

stalling a reflector in our tubing string in the hole.

Q. That was an alternative method that was cheaper to operate?

A. That is correct.

By the Court: What kind of reflector did you put in?

A. Originally we started out using reflectors made of canvas belting. The reflector was cut out of a strip of belting, with a diameter about one inch smaller than the diameter of the inside of the casing. This was fastened to the tubing collar by means of a clamp. These reflectors did not give [86] satisfactory echoes and we abandoned that and made a reflector in that shape out of lengths of old second-hand metal casing. They were about one inch smaller in diameter than the i. d. of the casing. They were flat on top with a rounded edge at the top and bottom; about three feet in length, and they were welded to a tubing collar. We simply took a collar off a joint of tubing, where we wished to install it, and installed this collar on the sleeve of the tubing. It was rounded, in order to facilitate in running and pulling from the well.

Cross Examination

By Mr. Graham: Q. Mr. Morris, in what form did Mr. Walker hand you or the company this information?

A. We stipulated that a copy, a graph of the original graph taken as a part of the test be submitted to our company, together with the form

(Testimony of Malcolm Wells Morris.)

which Mr. Walker had developed for reporting the information. That was done with these first tests that were made.

Q. Do you have copies of those graphs that were given to you when the first tests were made?

A. They are in the files, yes.

Q. Do you mean they are in the files of the company? A. That is correct.

Q. Can you produce those?

A. I can't this afternoon.

Q. Will you please do so? [87]

The Court: Can you get them tomorrow?

A. They are at Taft. It would necessitate a trip to the field, and an investigation of the files.

Mr. Graham: Some time before the conclusion of the trial—

The Court: At the rate we are going I don't know when the trial will be concluded. You will have plenty of time to go to Taft.

The Witness: We have quite a wealth of records of that nature. Can you stipulate the ones you are particularly interested in? It will save considerable time and expense.

Mr. Graham: The ones you have testified about. You said you were present when certain tests were made with the Walker apparatus.

The Court: Which ones do you want?

Mr. Graham: Those that were made in May, 1936; and August and December of that year.

The Court: What is it you would like to have him bring?

(Testimony of Malcolm Wells Morris.)

Mr. Graham: The reports and charts Mr. Walker furnished the company at that time after making those tests.

The Court: Those will be obtainable, won't they?

The Witness: I think so. To my knowledge they have not been destroyed, but I have been away from Taft for four years. It is not the custom of the company to destroy basic records.

Mr. Graham: Your Honor, I would like to know just what it was that Mr. Walker furnished the company. He furnished them with a graph. [88]

The Court: When?

Mr. Graham: I am still speaking about these different operations the witness has testified to, your Honor. For instance, in this that took place in May, 1936, what did Mr. Walker furnish the company?

A. He furnished the company a copy of the graph showing the echo measurements at the well; he furnished the company a copy of his interpretation of the depths that were involved in these tests, tabulated on a form, a standard form, which they had printed.

Q. And the information that was on that form was fluid level, is that correct?

A. Fluid level in all cases; well production; casing pressure; the producing conditions at the well, speed, and stroke, and other information on that order.

Q. Isn't it a fact that the information, quite a lot of it, was given to Mr. Walker by the company?

(Testimony of Malcolm Wells Morris.)

A. That is correct.

Q. In fact, all that Mr. Walker furnished were the fluid levels, isn't that correct?

A. He furnished fluid level and the depth of the fluid level, a copy of the graph on which he based his calculations. He compiled for us, on his printed form, the other information that we wished, to make a permanent record. We were particularly [89] interested in fluid level.

Q. Prior to the time that you saw these demonstrations by Mr. Walker, you had ways of estimating bottom hole pressures, didn't you?

A. We measured bottom hole pressures in wells that were producing under natural flow, under producing conditions, and under shut-in conditions. We measured bottom hole pressures in pumping wells under producing and shut-in conditions by means of a recorder installed below the pump.

Q. Then, in making a calculation of the information that you so received, did you calculate other conditions in the well, as to productivity potentials?

A. Yes, we call it capacity; we calculated the capacity or the productivity index.

Q. You had a formula for doing these things prior to Mr. Walker showing this apparatus to you, or demonstrating it?

A. We calculated the productivity index from pressure measurements. We measured pressure in the well, when it was not producing; that is, the static pressure. We measured the pressure in the

(Testimony of Malcolm Wells Morris.)

well with the well producing at any desired rate, and calculated the productivity index by dividing the barrels of oil obtained with the well producing by the difference in pressure under static conditions and producing conditions. [90]

Q. I will show the witness Figures 4 and 5 of the reissue patent in suit. There are two graphs here; I will ask him if he is familar with them.

A. Yes; we have done that.

Q. And you did that long prior to Mr. Walker coming and making his demonstrations, did you not?

A. That's correct.

Q. How did you compute bottom hole pressures prior to the time Mr. Walker made his demonstrations?

A. We did it in both flowing wells and pumping wells. In pumping wells we made it by installing a depth pressure recorder below the pump. We measured the pressure in the well with the well shut in, and we measured the pressure in the well with the well producing. We gauged the production the well made; calculated the productivity index by dividing the production by the draw-down in the pressure.

Q. I asked you how you plotted potentials. Take, for instance, as an illustration, a pumping well. How did you calculate the bottom hole pressure in a pumping well?

A. We measured it by installing a depth pressure recorder below the pump.

(Testimony of Malcolm Wells Morris.)

Q. So that you used pressure in your calculation?

A. We used pressure under two producing conditions; we used the difference in pressure between two conditions, [91] either producing or shut-in and producing.

Q. Do you get bottom hole pressures in any other way than by measuring it? You do not compute them in any manner from other information?

A. No.

Q. There is one question that is not answered. Will you read that?

A. We estimate bottom hole pressures currently with our current knowledge that has been obtained by accumulation of experience with the depth pressure recorder and with sonic testing equipment. By "sonic testing equipment", I mean by work that has been done by the Depthograph.

Q. I am confining my questions to your operations prior to the time that the Depthograph was used.

A. We have obtained our measurements in pumping wells through the depth pressure recorder.

Q. How did you use the information that you acquired, obtained by this recorder?

A. We used the information in calculating the amount of oil we expected to recover from the well and from the pool, and calculating what the capacity of the well was. If we found that we were not able to produce the oil to capacity with the equipment that we had installed, we were in a position

(Testimony of Malcolm Wells Morris.)

to make changes in the equipment or in our meth of operating that equipment in case we desired obtain more production. [92] "Potential" is broad used by the industry as a rating of the well. It h been used by the oil umpire or oil administrator a factor in determining the amount of oil that well will be permitted to produce. It is not nec sarily synonymous with "capacity".

The Court: "Potential" means what you c convince the umpire your capacity is, where "c pacity" is capacity?

A. That is correct.

Mr. Graham: Q. Prior to the Walker expe ments did you have other ways of obtaining t pressure, except by this pressure recorder that y mentioned?

A. We had no other accurate way of determi ing pressures. We used fluid level data obtained wi the wells shut in and the pumping equipment r moved from the well in estimating what botto hole pressures might be. The results obtained we extremely erratic, due to the lack of knowledge to the amount of gas that was entrained with t oil and to the location of the water column, wat having a higher gradient, higher density than c

Q. Just how did you go about figuring that that shut-in well, for instance, the bottom hole pr sure with a bailer?

A. Well, the bailer was run into the well by t well crew. The crew measured the position of t fluid in the [93] well and if we say, for examp

(Testimony of Malcolm Wells Morris.)

that the fluid leval was at 2,000 feet, and the oil sand was at 3,000 feet, we were in the habit of making an estimate as to the pressure at the bottom of the hole, assuming a gradient from 2,000 feet to 3,000 feet. These assumptions were grossly in error due to the fact that we frequently had foamy oil rather than tank oil, and to the fact that there were variable amounts of water likely to be present in the column. In any given well, if you had a thousand feet of fluid, all but 50 feet of that might be water, or 950 feet might be oil and only 50 feet water.

The Court: I thought you said this morning that this demonstrated that the density was the same all the way down?

A. I am referring now to the fluid level as found in a pumping well when the pumping equipment is out of the hole. There is no pressure on the well head.

The Court: Oh, when the pump is not pumping?

A. And there is no production. It is only when the well is pumping and you are controlling the production rate and the well conditions that your density is the same.

The Court: But when it is idle, I suppose the oil comes to the top and the water goes to the bottom?

A. That is correct; and the light frothy oil comes to the top of the heavy oil. In a pumping well the density is subject—while constant for any given producing condition, [94] it changes for dif-

(Testimony of Malcolm Wells Morris.)

ferent producing conditions in the same well. If you pump a well so as to remove 100 barrels a day and you pump it so as to remove 400 barrels a day, it is generally true that the gradient will be different for the two producing rates but constant for each rate.

The Court: Yes, I understand that.

Mr. Graham: Q. Does the Standard Oil Company still use pressure bombs, pressure recorders?

A. The term "pressure bomb" is oil field slang that is very greatly resented by some of the super-technical men. We employ the pressure bomb or depth pressure recorder.

Q. You referred a while ago to a chart or graph that you had there. May I look at that?

A. Yes. This is a graph of the readings that were taken at Abadie No. 1 between December 29, 1936 and December 31, 1936. It is a plot of fluid level in feet versus pressure of the fluid surface. That chart was prepared by one of my assistant engineers from the graphs that were taken by the Depthograph Company. The graphs showed the echo from the fluid surface. I gave instructions for this curve to be made.

Q. Where did you get the data, or how did you come to have a curve like that plotted?

A. The data was obtained by Mr. Walker on the well. He gave us a copy of the graphs and copy of the usual printed [95] report giving well conditions, his computation of the pos on of the fluid level and pressure of the fluid sur ce. He also

(Testimony of Malcolm Wells Morris.)

included a pencil graph which was a plot of that type. The indication of the constant fluid density was so startling that I had the pressure calculations and fluid level position calculations verified, and discussed the graph with other members of the staff. This graph was prepared under my direction for inclusion in a report which was prepared for the management of the Standard Oil Company. This was prepared in April of 1937.

Q. And it was on the preparation of this report that you became startled?

A. It was on receipt of Mr. Walker's graph. By the time this graph was prepared we had accepted and were using the method of determining bottom hole pressure under producing conditions.

Q. Now, among the documents that you are going to obtain and bring to us here in court you will bring this material or data that was furnished you by Mr. Walker?

A. I will bring everything that is still in the files of the Standard Oil Company.

Q. Will you include a copy of your report to the company?

A. Yes. If the court please, I am taking liberties. This information belongs to the Standard Oil Company of California and not to me personally. I believe it would be essential [96] that a directive be issued that these records be produced. They are not——

The Court: Do you know of any reason why they should not be produced?

(Testimony of Malcolm Wells Morris.)

A. I don't know of any, no; but I just work there.

Mr. Mattingly: Some of the oil companies are very reluctant to have their records used, without subpoenas.

The Court: Well, the records should not be required, even with subpoena, unless they are material and competent, and even there consideration should be given to whether or not there is any disclosure of trade secrets.

The Witness: There are two points I would like to establish here regarding this matter. One is that we are in a war, we are short-handed, we are just overloaded with work incidental to trying to produce oil for the war effort. I would like to keep any requirements down to the bare essentials because it does interfere with our other work. Secondly, this pressure information is held as confidential by Standard Oil Company of California.

Q. As to the particular well?

A. No; as to the pressures at a well because of——

Q. That is, as to each particular well?

A. Yes, sir. The point is that there are possibly legal [97] difficulties that may arise if competing operators or various interests concerned were able to obtain access to the information.

The Court: I will direct you to produce the information and if upon its production in court the company wishes to advance any reason why it should not be disclosed, I will hear their objections

(Testimony of Malcolm Wells Morris.)

at that time. In other words, the information will be here. My disposition will be to require a showing of its materiality. I will give, even then, consideration as to whether or not I will require disclosure of a trade secret. So you will produce them and I suppose that your company counsel—of course, you are not entitled to any lawyer, but, at the same time——

Mr. Fulwider: Your Honor, while we personally have no objection, of course, to them, in the event that the Standard Oil Company should wish to present objections would it be possible for Mr. Mattingly or myself to present those objections together with Mr. Morris?

The Court: Yes; that will be all right. I think you are entitled to cross-examine the witness concerning the matter, because he was examined on them directly. But as far as the results are concerned, they would come under the rule of memoranda made at the time and the opposite side is entitled to introduce them, if we rule strictly, and both only if they are used by the witness. [98]

Mr. Graham: Maybe Mr. Walker has some copies of these records.

The Court: What *are you* interested in is the copy of the records that Mr. Walker made?

Mr. Mattingly: Mr. Walker states that he has copies of some of these records that Mr. Graham has asked for, but not all of them.

The Court: I am sure that counsel, generally, will try to find what this defendant's counsel wants

(Testimony of Malcolm Wells Morris.)

to see, without embarrassment to anybody's trade relationships.

You will be notified to return at some specific date. Some arrangement may be made to inspect these documents, but you are under no obligation to show the cards; you are under obligation to produce them.

Mr. Graham: With the understanding that we have not finished, he may be excused at this time?

The Court: Yes.

Redirect Examination

Mr. Fulwider: Q. Prior to the time the Walker method or the Depthograph method and equipment, such as you described this morning, was there any way of accurately measuring fluid levels in pumping wells without shutting them down?

A. I am not familiar with any way. [99]

Q. In your testimony you used the term "sonic methods." Are there any other methods or apparatus on the market for determining fluid levels and other subsurface measurements besides Depthograph, that are known as sonic methods to the trade?

A. The term "sonic measurement" is used on paper in depth pressure data in the determination of well potentials in California to denote tests made in California by the Depthograph method and the Echo-Meter method. It is used as a general term, covering the two methods.

Q. That is a generic term used in the industry to cover both methods?

(Testimony of Malcolm Wells Morris.)

A. That is correct. The Echo-Meter method is now offered by the Halliburton Oil Well Cementing Company.

Recross Examination

By Mr. Graham: Q. Do you know Harold Wyatt?

A. I am acquainted with Harold Wyatt, yes.

Q. Do you know Mr. Lehr?

A. I am acquainted with Mr. Lehr.

Q. Did you ever hear of anything that they developed for determining fluid levels?

A. I met Mr. Wyatt in 1936, and Mr. Lehr in 1937. I had heard, previous to the time that I met the two gentlemen, [100] and previous to the time that Mr. Walker came to our office and explained the Depthograph method and apparatus, that Lehr had been doing experimental work with the Shell to determine the position of fluid level by introducing a pressure wave into the casinghead of a well. I had no knowledge as to what apparatus he used.

The Court: Or the results? Did you have any knowledge of his results?

A. I had no knowledge of his results.

Mr. Graham: Q. Did you know enough of the Wyatt and Lehr apparatus to know whether or not he used a pressure impulse chamber, like this tank you said Mr. Walker had?

A. I was not familiar with that. At that time you can appreciate, I would imagine, they were keeping this a confidential topic; they were in the

(Testimony of Malcolm Wells Morris.)

development stage, and I heard of it only in general terms through friends of mine in the Shell organization.

Q. You heard of some work being done also at the Union Oil Company?

A. I was not familiar with any work that the Union was doing at that time.

Q. You did not know of that work prior to the time Mr. Walker came to you?

A. I did not know anything about the Union Oil Company work until in 1937, at which time we were approached by the [101] International Geophysics Company regarding a method of testing wells, which is now known as the Echo-Meter method, and that representative told me that preliminary work had been done in Union Oil Company wells.

The Court: In December, 1936, when you learned from the tests on the Abadie well, by the Walker apparatus, that the fluid in a pumping well had the same density throughout, had you heard of any method prior to that time of ascertaining or computing the density of the fluid in a flowing well?

A. In a flowing well we had customarily been measuring the gradients directly with our depth pressure recorder.

Q. That was at the pump?

A. This was in a flowing well; no pump to it.

Q. I meant a pumping well.

A. We measured the pressure at the bottom of the pump in the well at a single point in the well.

(Testimony of Malcolm Wells Morris.)

We estimated; we assumed a gradient in transferring that pressure measurement at one point to the sand, in estimating the pressure at the sand. It was customary with me at that time to assume a gradient equal that of tank oil corrected for the temperature at the bottom of the well.

Q. Prior to that time had you heard of any method of ascertaining that; I mean, prior to this Walker method in the Abadie well, had you heard of any method of ascertaining [102] that density of fluid in the well? A. I had not.

Later in the trial, the following colloquy occurred:

Mr. Mattingly: Your honor, Mr. Morris has come into the court room today with the various records Mr. Graham requested him to bring, and they have been submitted to Mr. Graham for his inspection and they are in the court room for the inspection of the court and counsel, but the Standard Oil Company has requested that they not be made exhibits in the case where they may be open to the public.

Mr. Graham: Your Honor, we appreciate the production of these, but the one we wanted particularly was the pressure depth chart that Mr. Walker gave to the Standard Oil Company, and Mr. Morris, from which he made up the chart that he testified about, and these others, I can't see that they will add anything to the graphs—that's what they are; in other words, the record made by the machine of

(Testimony of Malcolm Wells Morris.)

what is already in evidence; consequently, I do not believe we have any further questions to ask Mr. Morris.

The Court: You have examined the records that you desire?

Mr. Graham: Yes, we have examined these documents which they have produced.

The Court: You don't desire any of them?

Mr. Graham: No, your Honor. I will just explain to the [103] Court that they are graphs like a lot of these that have been introduced, and have a lot of data about the wells of the Standard Oil Company, and it is going to take ten days if we try to get that all straightened out, and as I say, they are not of sufficient importance to go in. [104]

EMMET WALTON GILBERT

called on behalf of the plaintiffs, testified as follows:

My address is 118 South Croft Avenue, Los Angeles. I am a mechanical engineer, a graduate from Cal. Tech. in 1923. I am employed at this time by The Shell Oil Company, Inc. I went to work for them in 1927 in the geological department. My duties were various. I ended up there as a research engineer working on special development problems. During that period of time with the Shell Company I designed and built equipment for use in surveying wells. I developed an instrument for

(Testimony of Emmet Walton Gilbert.)

determining the bottom hole course of oil wells, the inclination and direction of drift. I left Shell in 1931, and was gone until 1934, when I was called back. I have been with them since in the field engineering department. I was an equipment engineer, concerned with the development of drilling and production equipment, the selection of equipment, and the development of improved equipment. My duties include keeping abreast of developments in the industry. That is essentially the purpose of the job. I did work that might be classified as research. I developed an instrument for measuring the work done at the bottom of a pumping well, getting dynagraph records down there, which gave the work, the stroke length, and fluid load on the pump, and gave us a much better insight into the pumping action than we had previously. I am a member of the American Petroleum [105] Institute. I have held most of the offices that fall in my line of work. I finished up as National chairman of the Drilling and Production Practice Committee. In connection with that work I had occasion to supervise or initiate research work done by other companies. I have attempted to summarize the developments that were current, and in such sense initiated developments along lines that seemed necessary for the proper development of the industry.

By Mr. Fulwider: Q. Can you tell me whether, prior to 1936, the oil industry as a whole, or as

(Testimony of Emmet Walton Gilbert.)

you were familiar with it, recognized the value of determining subsurface pressures in oil wells?

A. Oh, yes; C. V. Millikan of the Amando Company developed a recorder which was first used, I believe, in 1930. There was quite a program on bottom hole pressure work going forward under his direction in 1931, and the industry, as a whole, in the years that followed that developed a very clear conception of the need for bottom hole pressure data.

Q. Up until the latter part of 1935 was there any method or apparatus for determining bottom hole pressures in a pumping well, without removing the pumping equipment?

A. I never heard of any. I am familiar with what are called depth pressure recorders or pressure bombs in a general way. They were the first apparatus ever used for bottom hole pressures. The first recorders did not have clocks, and could not have been [106] used on a pumping well. It was after they had put clocks on those recorders that they could be put on a pumping well, but the rods had to be removed and the tubing, of course, in order to make a run. There are particular advantages to determining bottom hole pressures while the well is pumping; particularly, there are wells which don't reach a steady producing condition in perhaps a day or two days, in some cases, and when you run the recorder in, I think the maximum time that recorder is effective is 72 hours. You can't get more than one or two steady rate read-

(Testimony of Emmet Walton Gilbert.)

ings often in that time, and then you are not too sure of yourself. When you are at liberty to maintain a steady condition as long as you please you can assure yourself of having reached a steady condition before proceeding to another steady rate. That is possible with the Depthograph equipment.

I am acquainted with Mr. Cranford P. Walker. I am familiar with his equipment called the Depthograph equipment. He ran tests and did work for the Shell Company. I first became acquainted with Mr. Walker's Depthograph work either in the latter part of '35 or early in 1936, and I can't be sure. I was in more or less close touch with him during that period of time, say, from the early part of 1936 up through 1936 and 1937. I instructed him to keep me closely advised when he did a job.

Q. Can you tell us briefly what apparatus and method [107] Mr. Walker was using in the early work, say, in 1936, the spring of 1936?

A. I am no adept at verbal descriptions, but he had a pressure flask for initiating pressure-impulse in the casing of the well, and he was at that time using reflectors down the hole as a means of calibrating the velocity of the waves thus set up. The wave reflections were reflected or hit a diaphragm at the surface and the diaphragm actuated an oscillograph and he depthographically made a record of the vibrations thus recorded through the diaphragm. There were other details but that is essentially what he did. The graph that he got by

(Testimony of Emmet Walton Gilbert.)

that, gave him a record of the depth to the fluid level.

The Court: When was that?

A. Well, I wrote a report showing that which was published in our company records in October, '36, but I think that was probably going on at least five or six months prior to that.

Mr. Fulwider: Q. And by the recording of those fluid levels he determined bottom hole pressures?

A. Yes, he used that data very effectively.

Q. Can you tell me did Mr. Walker advise you or disclose to you during that period of time anything about fluid densities?

A. I think it was a surprise to most of us that the gradients that he recorded were so straight. The ability to extrapolate his data was obvious after you had seen his record. [108] Now, we had no previous conception that the density-depth relationship would be as easily projectable as it was. I think nearly all of us were much surprised at that discovery.

Q. You mean his discovery of that relationship?

A. Yes.

The Court: What relationship?

A. The relationship, your Honor, between pressure and depth in the gas-liquid column in the annulus.

Q. In the fluid? A. Yes.

Mr. Fulwider: Q. You mean of the density of the fluid itself, that is, the mixture down in the well?

(Testimony of Emmet Walton Gilbert.)

A. The fluid mixture; yes.

By the Court: Q. Explain a little more about what you mean that you had no idea that the gradient was——

A. Your Honor, an offhand conception of the thing might be something like this: The deeper you go the greater the pressure and the smaller would be the space occupied by a certain amount of gas, and you might set up a mental conception of going down there, the gas being progressively compressed and occupying less and less space.

The Court: That is in the annular space in the tubing?

A. Yes. As a matter of fact, that gradient is quite regular and, for all practical purposes, within the limits of accuracy of a straight line. [109]

Q. The reason you say that, the ordinary conception is likely to be that the deeper it is the greater the density, is that right, because the greater the pressure?

A. Yes. Of course, we know now as a result of his work that it is more or less directly related to the depth; that it is a straight line relationship. If you go twice as deep it is twice as dense—I mean, the density is a uniform density with depth. May I change that? That is not right.

Mr. Fulwider: Go ahead.

A. It is a straight line relationship. You would expect—we were led to expect something quite differently.

The Court: Q. What were you led to expect?

(Testimony of Emmet Walton Gilbert.)

I mean, what did you believe before you discovered that?

A. Well, I wouldn't have believed that you could get an easy curve that could be easily projected.

Q. Well, I still don't know what that means. I know what "curve" or "easily projected" is, but what has that got to do with the density of the fluid?

A. Well, when I referred to a curve I meant the density with reference to depth.

Q. Yes, I understand your curve that way. You found out after these experiments and his discoveries, or whatever it is he did, that the density of your fluid is more nearly uniform than you had expected, is that correct?

A. That is correct. [110]

Q. Well, why didn't you expect that?

A. Oh, probably poor engineering.

Q. I mean generally in the industry?

A. I can't speak for other people in the industry. I know that I was surprised and I have met several other individuals who were equally surprised, because we would have been led to expect that, as you go deeper the same gas would occupy less space.

Q. Due to the weight of the gas itself?

A. The column above.

Q. In the column of water and the column above it? A. That is right.

Q. What does this show, that it does not occupy less space?

(Testimony of Emmet Walton Gilbert.)

A. No; it occupies less space, but in doing so it does not have a rate of gradient equal to most——

Q. That is to say, it does not occupy the same, that is, relatively less space according to its greater depth, or it does occupy relatively less space according to its greater depth?

A. Well, apparently as you go deeper the weight of gas per cubic foot increases in such a way that the gradient is, for practical purposes, a straight line. It is a constant gradient, more or less.

The Court: I have seen these charts around here. There [111] is one over there on that board marked Fig. 3. Have him go down there and explain, or have somebody explain what that means.

(The witness refers to Fig. 3 of Reissue Patent 31,383).

Well, here we have a relationship between the fluid level and the pressure on the fluid level surface in pounds per square inch. If you depress the fluid level to this point here, then the pressure would be this pressure down here.

The Court: Would be greater?

A. Would be greater, but the slope of this line is constant within reasonable limits.

Q. Constant in all wells?

A. No, no; in this particular well for this one steady rate condition. We are now pumping along at some definite barrels per day rate and some more or less constant——

Q. The pressure would be greater at the second point? A. Yes sir.

(Testimony of Emmet Walton Gilbert.)

Q. What would reduce the fluid level because you would have to put more weight on the column, wouldn't you?

A. We impose gas pressure from the surface.

Q. And is there something unusual about that? I mean, you put more pressure on it and there is more pressure on it; that is what I understand you to be saying.

A. No. What I am saying is that I did not suspect this would be a straight line relationship, your Honor.

Q. What did you expect it? [112]

A. I expected it to be very much curve in it.

Q. Why?

A. Because, as you go deeper the gas—I mean the cubic volume of gas will occupy less space the more pressure it has on it, according to Boyle's law it is inversely related to the pressure, or volume occupied by any——

Q. Then you thought from that experiment, under your previously existing theories, it should have resulted in a curved rather than a straight line?

A. Yes; or more of a curve than we have any reason to believe exists there. If it had been a severe curve, your Honor, we could not have taken one or two readings here and usefully extrapolated them down to this point, which is what we desire, the pressure at the pump.

Q. Why would it have been a curve?

(Testimony of Emmet Walton Gilbert.)

A. Of course, your Honor, you are asking me to explain my own ignorance and it is not very pleasant.

Q. No; I am not. I understood that in the industry those with whom you talked had the same idea.

A. Yes. I have had the experience, after I was so thoroughly acquainted with this, of having to explain it to other engineers and trying to rationalize it. It was something that was not easily grasped or quickly understood. [113]

Mr. Fulwider: Q. What kind of a curve would you have expected to get prior to the time Walker discovered this constant density condition, referring to this chart here, Fig. 3?

A. It would have been a concave affair like that, rather a steep change.

Q. With what you would have expected from your previous knowledge?

A. Probably previous lack of knowledge.

Q. Well, summarizing it, then, if I get this correctly, the fact that that relationship was substantially a straight line relationship was a surprise to you. From your previous work you had been led to believe that it would have been a curve if you plotted those results? A. Yes.

The Court: I don't know why it would have been a curve. I can understand why you would expect that it would go down vertically, but why would it come down to the bottom of the curve there and taper off again, upon what theory?

(Testimony of Emmet Walton Gilbert.)

A. Well, if a gas occupied less space, your Honor, since you would not have any voids down there you might have more liquid in the space not occupied by the gas.

Q. Well, I am describing an arc here now. When it comes down here it begins to taper off, doesn't it, and it comes over horizontally instead of vertically?

A. If we could conceive of no gas passing up through this [114] column and we had a uniform mixture from top to bottom, with no motion in it, you would get the kind of thing I am talking about. If we had little rubber balls, each filled with that same mixture, piled one on top of the other, then you would get a much greater curve than you have here.

Q. Let me see. The reason we expected a curve was because it would reach its maximum some place down there on that curve, is that right, the maximum amount that the gas could be compressed into?

A. Yes; there is such a maximum where it would go into solution, so far as that goes.

Q. And otherwise it would have continued on?

A. A curve down to that maximum, yes.

The Court: I see. I think that explains it a little better.

Mr. Fulwider: Did Mr. Walker ever compute fluid levels by counting collar echo peaks on the graphs which he obtained with this Depthograph?

A. Yes.

(Testimony of Emmet Walton Gilbert.)

Q. Will you tell us any conversations that you had with Mr. Walker about the methods of counting collars?

A. Well, I think that I knew about his use of that method shortly after he started to use it, but I can't quote you an exact date. It was subsequent to October, 1936, when I wrote my first regular company memorandum on the subject. It [115] was some time in 1938 that I wrote another memorandum that covered that subject of counting collars.

Q. Can you tell us very briefly what that method consisted of?

A. It was a method of selecting the tube length from the well to the diaphragm in order to reinforce the waves reflected from each collar. And then he determined something like one-third the distance between two collars was the desired length to have between the well and the diaphragm—the well head and the diaphragm, and whatever the details of that are, he was able to so regulate the space there that he reinforced the collar reflections to such an extent that he could reliably count them and so determine the velocities of the waves traveling up and down the annular space.

Q. Prior to the advent of Mr. Walker's Depthograph equipment was there any method, to your knowledge, for determining fluid levels in a pumping well other than the pressure bombs and other systems which required the shut-down of the well?

(Testimony of Emmet Walton Gilbert.)

A. We had a rudimentary Lehr-Wyatt device that we used or attempted to use for that purpose.

Q. Will you describe that very briefly as to what that consisted of?

A. It amounted to simply a flask that either had pressure in it, or if you were operating with a well casing pressure you could simply fill the flask and start a vacuum wave down it. By [116] either of those methods you would start a wave which can be reflected, and then in the earliest expression of this device we simply had an escape of gas from the casing and a man would hold his hand in front of it and when a puff of pressure came back that was timed from the inception of the wave and we got a very rough notion of the reflections. It was quite inaccurate. It took a man with a sixth sense to be sure that he was getting the reflection from the fluid interface and not from something like a tubing catcher or the top of the liner. We were never sure of our results and we were glad to have something more authentic and useful.

Q. Did your company ever put any kind of a recording or indicating device in the Lehr and Wyatt apparatus?

A. Yes; I believe they experimented—not with a recorder, because it never got that far, but they did put a diaphragm with a needle attached to the diaphragm. Your needle would jump up so that we had a visual rather than a factual indication of the return of the wave.

(Testimony of Emmet Walton Gilbert.)

Q. Were the results that you obtained from that satisfactory?

A. No. They were no more satisfactory than the first. The Shell Company operates a Depthograph machine now. We have had it—I don't remember exactly when we got it, but it is over a year ago and we have used it to very good effect ever since we have had it. It is working very hard now. It is one of Mr. Walker's machines. [117]

Q. What is the arrangement between your company and Mr. Walker for the use of that machine?

A. We rent it. We have an arrangement by which we, I think, pay the lump sum covering the cost of it and also pay a rental. It is operated by our own people. That machine which we are now using is similar to the equipment which I previously described in all essential details. It has some minor improvements, but it is the same practical apparatus.

The Court: The same as what, Wyatt and Lehr or what?

A. No; as developed by Mr. Walker in the early part of 1936.

Mr. Fulwider: Q. As described by you in your previous testimony? A. Yes.

Q. Are you familiar with the International Geophysical apparatus called "Echometer"?

A. I have seen it but I can't say that I am very familiar with it.

Q. At the time your company made arrange-

(Testimony of Emmet Walton Gilbert.)

ments to run this Walker Depthograph machine did you make any investigations of such other equipment as there was on the market for accomplishing the same thing?

A. Yes. There were only the two makes, the Echometer and the Depthograph. I did not have an opportunity to test the two [118] instruments at the same well, which would have been the most definite method of approach, and such investigating as I did was limited to obtaining opinions of people who had used either one or both, in reaching a conclusion on the basis of information obtained.

I would think that we had this Depthograph over two years.

Q. Has the Depthograph machine which your company operates always proved satisfactory?

A. There are limitations to the use of any instrument you can think of. There are instances when the Depthograph is not applicable, but they are very few, and it has proven very useful to us in our pumping well practice. I think it is very exceptional when we find an instance where we can't get useful results with the use of the Depthograph.

Cross Examination

By Mr. Graham: Mr. Gilbert, in this report that you made in October, 1936, do you recall whether you said anything in that about tubing collars?

A. I recall that I did not say anything about tubing collars.

(Testimony of Emmet Walton Gilbert.)

Q. When was it that you found out about these tubing collars from Mr. Walker?

A. I can't tell you exactly.

Q. Was it prior to that time or subsequent?

A. No; it was subsequent to that time. [119]

Q. As far as the operation of that Wyatt and Lehr apparatus and getting reflections from the fluid level, could you get anything more as far as getting the fluid level is concerned with the Walker apparatus than you did with the Wyatt and Lehr?

A. Yes. You could have some certainty that you were getting the fluid level and not the reflection from something else. It made the difference between being sure of yourself and being very uncertain about yourself.

Q. Why do you say that? You got a puff, in the one instance that you spoke about, and it was a matter of computing time, was it not?

A. Yes; and I said we got a puff but only the adept could tell you whether it was one puff or five puffs. At times it was quite indefinite and, as we later learned, sometimes the actual reflection from the interface was of lesser intensity than the reflection from some other obstructions, and that the result, you had no means of checking which reflection you were reading.

Q. Then the difficulty with the Wyatt and Lehr apparatus was a proper recording mechanism, is that correct?

A. That was a part of what was necessary to accomplish what we later accomplished.

(Testimony of Emmet Walton Gilbert.)

Redirect Examination

By Mr. Fulwider: Q. When you use the term "interface" you mean that as being the fluid surface, do you not? A. Yes? [120]

RICHARD W. FRENCH, JR.

a witness called on behalf of the plaintiffs, testified as follows:

My address is 1122 Milan Avenue, South Pasadena. I am a graduate engineer from the University of Delaware. I graduated in 1929. After graduation, I served a year with the General Electric Company, and studied engineering, doing special mechanical testing work, taking their advance engineering and administrative courses, following which I served two years and two months in the army air corps as a flying cadet, on active duty, after which I have been working in oil; that is, since February, 1933, employed by the Continental Oil Company. Starting as a roustabout in the field, in 1933, I have worked in addition, as a gang pusher, in field terminology, compressor plant engineer, gas dispatcher, field production engineer. In 1936, in April, I was promoted to the job of production engineer for the Continental Oil Company west of the Rockies. I now handle all the engineering supervision or work connected with the drilling in exploring and developing oil properties

(Testimony of Richard W. French, Jr.)

to produce oil and gas. One of my duties is to keep abreast of the development in the production and drilling problems in the oil industry. That is an important, implied duty at least.

I have discussed developments with engineers of other companies so as to be familiar with what they are doing. That is, carried on also in formal discussions, in the course of the [121] *the* activities of the American Petroleum Institute and other professional organizations. I am not a member of the American Petroleum Institute right now. I have been. I think I am a little disconnected at the present time.

I have had occasion to write or collaborate on papers relating to subsurface data. In 1941, I was chairman of the National Production Practice Committee of the American Petroleum Institute, and a year before for the California District, in the same function.

Mr. Fulwider: Q. Prior to 1936, did the oil industry recognize the value of determining fluid levels, fluid densities, and subsurface pressures in oil wells?

A. Yes, I think they and we had recognized it long before that. Without those data it is impossible to determine whether you are producing an oil well efficiently, and whether you are getting all the oil that could be taken from it, and to know the exact behavior.

The Court: Why?

(Testimony of Richard W. French, Jr.)

A. Your Honor, without being able to mathematically evaluate how much oil can come in the bottom of an oil well, and having knowledge only from what you get out of the top, you are left a blank in your knowledge, and can't tell whether you are getting all the oil that is coming out of the bottom, from the top indications. An oil well has various rates between the low, intermediate and full quantities that [122] enter the bore hole from the oil reservoir, and without this data you can't be informed as to the quantity; you can only form an estimate of it, and you have no mathematical estimate as to whether you can get 200 barrels a day, if you have the necessary equipment, or all you are getting is 80 barrels a day.

The Court: Does this have anything to do with determining whether or not you could read pressure in sand?

A. Not directly. I would say it has some corollary in analyzing this thing, whether you could read pressure in sand, but not directly. I think the main importance is the one which we are dealing with today. We have a very strict practical problem in the field on equipment today. We can't get any more steel than we need. In fact, the situation is stringent, but we do need all the oil we can get. And we do have the fields now where it is important to use the pumping unit in accordance with the capacity. Some wells have a capacity of 100 barrels and some have a capacity of 500 barrels. We put

(Testimony of Richard W. French, Jr.)

them on wells so they can pump the fluid that they are capable of making. The only way I know of fitting that equipment to the well's natural production capacity, so that you can get the most out of it, is through data like that.

The Court: What difference does it make what the density of the fluid is?

A. Without the density it is impossible to calculate [123] the pressure. The pressure is the key to telling how much oil you can get from an oil well.

The Court: That is, the pressure under the fluid; that is what you are talking about?

A. Well, the pressure under the fluid or in the hole, 10 feet, 20 feet, or any distance. If you know the density you can take the depth and calculate what the pressure is at that point.

The Court: Why?

A. Because it is just a matter of determining the pressure exerted by any fluid column. The air in this room is fluid, but it is so light we don't think of it as such. It is a substance that is capable of exerting a definite pressure. You take a column of water in a pipe, for instance, 20 feet high, you would be able to calculate the pressure at the bottom, knowing that the water has a pressure of 62½ pounds. Any time you are able to tell the density of a fluid, then you are able to determine what the pressure is in that fluid, whether it is a mile down or a foot.

The Court: You mean it is the same all the way down?

(Testimony of Richard W. French, Jr.)

A. No, sir. The pressure varies with the depth. It can't be the same with a common density fluid.

The Court: If you had a 6-inch pipe, the density would be the same all the way down? [124]

A. Yes. I understood you to say, is the pressure the same? In that case the pressure is the same and your density is constant in that case.

The Court: The density is weight?

A. The density is an expression of unit weight, the weight per unit of measurement.

The Court: The greater weight you have the greater the pressure. A. Yes.

The Court: How do you express density, in inches?

A. No. There are several ways of doing it. In this work we express it as a gradient. In other words, we express it as the net result of what we are trying to get, the pounds per square foot. The square inch pressure you get each foot you go down in the hole is expressed, then, as a gradient. The gradient for plain water at ordinary temperature would be about .434. In other words, every foot you go down, with plain water at ordinary temperature, you increase the pressure .434 pounds per square inch. Oil is less dense and instead of increasing the pressure .434 pounds per square inch for every foot you go down in the well, it would be .33 for ordinary oil. It is a lighter fluid.

The Court: How can you tell what the pressure is if you don't know the character of the fluid?

[125]

(Testimony of Richard W. French, Jr.)

A. That is just it. You can't.

The Court: You determine whether it is mud or oil by the pressure?

A. No. In this case, that is it; you can't tell the pressure unless you know the type of fluid. Therefore, you have to know whether it is plain water, whether it is mixed oil and water, whether it is gassy oil, which might be quite light——

The Court: And you can tell it by displacing it?

A. That is right.

The Court: And by the method which the plaintiff is using?

A. Yes, in general, I don't know if he has given any specific data, but in general his method is used exactly like that.

The Court: That is what they are quarreling about here, the method.

A. That is the key to the whole problem. It is easy to predict pressure if you know what fluid you are dealing with.

The Court: And you can find what fluid you are dealing with by pressure?

A. That is right. You find the density, then you are able to predict the pressure and very closely calculate it.

The Court: As well as the gravity?

A. Yes. Gravity is another expression for density. It is in different terms. There is another one; specific weight. [126] In other words you are just mathematically rearranging the figure. It is the same thing.

(Testimony of Richard W. French, Jr.)

Mr. Fulwider: Q. You are familiar, are you not, with the apparatus known as a depth pressure recorder or pressure bomb?

A. Yes, that was used prior to 1936.

The Court: What is that apparatus, now?

A. What he calls a pressure bomb we call a subsurface pressure recorder. Your Honor has probably seen pressure gauges on boilers and pieces of equipment.

The Court: Yes.

A. We wanted similar equipment to put down an oil well, but you have too small a diameter of casing to get it down in the earth a couple of miles. So we built an instrument in a cylinder case, about that big in diameter and about that long. It is a rather precise pressure gauge, nothing more, except it draws a little graphic record of the pressure.

The Court: You run that in the oil well?

A. Yes, you may at times, when you don't have a pump, run it on a wire line. Then that pressure gauge records the pressure at the depth you stop.

The Court: At the depth you stop?

A. Yes. Then you can run it at different depths and get pressures every hundred feet in the oil well if you wish.

The Court: That is, get the information that this method gives you? [127]

A. Yes. They are both derived at the pressure. However, running this instrument on a wire line, it is not possible when you have the hole full of

(Testimony of Richard W. French, Jr.)

pumping equipment. It is only in flowing wells where you don't have the pumping equipment.

Mr. Fulwider: Q. A pressure recorder can't be used in a pumping well while it is pumping?

A. Well, the pressure can be run in a chamber below the pump.

The Court: But you have to pull out the rods and pump?

A. Yes, you have to take the rods out and put them in again, and sometimes pull the tubing, too.

Mr. Fulwider: Q. Were there any other methods, to your knowledge, that could satisfactorily measure subsurface pressures prior to 1936, other than this depth pressure bomb or recorder?

A. Well, the word "satisfactorily"—I would have said no, but with the word "satisfactorily", I did read of another experimental device for determining pressures in a well without pulling it. They never, to my knowledge, used it commercially until the last couple of years, and then only in very shallow wells. Just from reading in the literature, I recall an article which told of the Gulf Oil Company and Midcontinental running a piece of small copper tubing perhaps 1/8 of an inch in diameter, a quarter of an inch in diameter, into wells—conceivably it could be on the bottom of the tubing and the casing—and using this [128] device to lower the tubing to a certain depth. They pumped hydrogen, I think, through the tubing until they reached an equilibrium pressure, which meant that the tubing was full of gas and had

(Testimony of Richard W. French, Jr.)

forced all the liquid out. Then by reading a pressure gauge and knowing the density, they could calculate the pressure. But that method has never been used mechanically; it is very difficult; except in the last two years one experimenter in California did use the same method in a couple of very shallow wells; I think 1600 feet deep, or something like that; but I have never heard of any deeper ones or any practical use, because of the mechanical difficulty. If you put a small copper tubing down a deep well you are liable to get it wrapped around and never get it out. And there is, also, the mechanical hazards in trying to put it down near a pump, where we want to get a pressure in a pumping well, because the common practice in oil fields is to put what we call a tube catcher, which is a safety device—we put that quite a ways above the pump, and that would ordinarily preclude putting this delicate gauge down to it. So that device, while I have heard of it, I have not used it or know of anyone that has used it, except in the few shallow wells.

The Court: You heard of it when, in 1936?

A. I think so. I think it was in the engineering literature prior to that time. But I don't know of anyone using that. Whether it was ever put in a well, I don't [129] know. It could be found out, probably.

Mr. Fulwider: Q. Do you recall whether that was an article by Stanley Gill in the Gulf Publishing Company—This is a copy of one of the pub-

(Testimony of Richard W. French, Jr.)

lications which was cited by the defendant in his answer.

Mr. Graham: That hasn't been offered yet, your Honor.

The Court: All right. Let's mark it for identification now. K for identification will be described for the record as a *bookley* of prior publications compiled by the defendants. We will describe this as articles by Wilde and Moore, Gill, Hawthorne, Ihrig, Christie, Nix, Millikan and Vietti. You are referring now to the articles by Gill.

Mr. Fulwider: Referring to the article by Gill, in Exhibit K, do you recall whether or not that is the article that you read which you have just described?

A. It is the identical equipment. I notice that this is a Gulf publication. I may have read it in one of their magazines, but it is the exact equipment I spoke of.

Q. If I understood your testimony correctly, to your knowledge, that had never been practically used until very recently, and then only on shallow wells? A. That is right.

The Court: What is the date of the publication?

A. On the second page it says "Oil Weekly, April 4, 1932". [130]

The Court: It is stipulated that that is the publication date of that article?

Mr. Fulwider: We are agreeable to stipulate to that, yes.

(Testimony of Richard W. French, Jr.)

Mr. Graham: Can we at this time stipulate to the publication date of all these articles at once?

Mr. Mattingly: Yes, we don't question the publication.

The Court: Let us get the dates while we are at it.

Mr. Mattingly: The Wilde and Moore article, your Honor, is a publication dated June 30, 1931. It was published in the transactions of the American Petroleum Institute. Hawthorn has a publication date of January, 1933. That was published in the transactions of the American Institute of Mining and Metallurgical Engineers; that is usually abbreviated "A.I.M.E."

The Court: The Tucker articles of The Royal Society comes before Ihrig in this book.

Mr. Mattingly: January 5, 1923.

The Court: Ihrig is October, 1935?

Mr. Mattingly: That is correct. The Ihrig was published in the Oil and Gas Journal. Christie was a publication of the A.I.M.E. and was published in 1932. Millikan was published in 1931, American Institute of Metallurgical Engineers. Vietti was published in 1931, again A.I.M.E. Nix, in the A.I.M.E., and the year is 1932.

The Witness: I am acquainted with Mr. Cranford P. Walker, [131] and with his apparatus and method, which is known as the Depthograph equipment. They are in general use. I am unable to name the date I first became acquainted with Mr. Walker's equipment because we heard of this new

(Testimony of Richard W. French, Jr.)

equipment, and then we knew someone who used it, and finally used one ourselves and it received increasing use; as I recall, we first began hearing of its use, in my own case, early in 1936. My company has had a great deal of work done by Mr. Walker and his Depthograph equipment. That work has been satisfactory.

Mr. Fulwider: Will you explain very briefly your conception of the Depthograph equipment; how it operates, so we will know what we are talking about?

A. This will be a feeble explanation compared with some of the others, but it is equipment that contains a high-pressure gas chamber which through a quick-opening valve throws a pressure wave between the tubing and the well, ordinarily a pumping well. They have a device for recording the time of this initial impulse on some type of oscillograph or a type of camera with timing integrated into it, which records pressure waves. I am not competent to say whether it is sonic or ordinary, or what mode of pressure waves. We can make a record on the Depthograph, and record obstructions in its path, even on collars now, so you are able to not only get a record which would give [132] the velocity, but you can also find the spacing of all the interruptions in this annular passage. In other words, spacing on collars and tubing catchers. In the early days, I have heard, people put on special markers to detect it.

(Testimony of Richard W. French, Jr.)

The Court: And you calculate those pressure waves, the speed of them by the sound?

A. No, it is my understanding that the velocity varies with the density of the gas, which, of course, varies with the pressure and one thing and another.

The Court: Does the velocity of sound vary with the density of the medium through which it travels?

A. I should have boned up on my physics. I believe it does. I think the velocity of sound which is being associated in present aircraft propellor speed at the tip, I believe that is different in high altitudes, because of the much lower density; but an apparatus, at any rate, having this high-pressure gas cylinder to make a wave on an oscillograph, to time its start and finish with every variation which is caused by the interruption below the annular space, and it does make a record from which you can calculate the information I have just described.

The Court: When you calculate that information what speed do you apply to the pressure impulse?

A. To simplify this troublesome question of gravity, the simpler method, the one we use now, is this: When we put the [133] tube in the hole, we measure carefully and count the collars, and we know how far apart the collars are that are used, and don't have to worry about the velocity, because we have actually had a record or count of the collars. Say we had twenty collars, and they were twenty feet apart, and it takes 1/10th of a second

(Testimony of Richard W. French, Jr.)

for the wave to pass, we can then calculate the exact velocity.

The Court: Whether you know the density of the fluid in the annular space or not?

A. That's right.

The Court: What standard did you take to measure the return of the sound before you counted collars, the standard of sound?

A. No. My company has, I believe, a complete record in the field of what we put in the hole, and there was a method we had of actually determining the velocity for the particular gas in the well, by having a fixed target. Perhaps they would run an obstruction in, and check the well, and they knew what depth and by timing the wave to that obstruction and back, they could determine the velocity.

Q. When you say "they" could determine, you mean Walker, and the Depthograph Company, do you not?

A. They are the ones I had experience with. Instead of saying "They" perhaps I should have said it was possible to do this.

Q. This method you have just mentioned, counting collars, [134] and comparing the time allotted between the time of the known reflector and unknown, to the fluid level, those were the two methods used in determining fluid levels? A. Yes.

The method used by Mr. Walker in determining the bottom hole pressure from this data he got on his chart which showed the fluid levels was as follows:

(Testimony of Richard W. French, Jr.)

The first step was to determine what the fluid level was. The fluid level is important. It marks the difference usually between the two columns of different densities, to be added up to get the pressure down below. Below the fluid level you have a much denser fluid pressure, of perhaps oil and water. Then you get the pressure determination, and make the inference about what its density is, whether it is heavy or light, or it is partly oil, or partly water or partly gas. So the next step is to determine what the actual density is below the fluid level. I might remark that before that we had to estimate what it was under actual conditions, and we would stop the well at a certain point, and measure the fluid level as the well normally operated. Perhaps it was 1000 feet down in the well to the casinghead, and ordinarily a lot of gas would separate from the oil in the well, or escape, or be taken off in the gas meter in the annular space between the tubing and the steel lining. So the valve which lets that gas escape is partly closed by a regulator, and as it is closed the pressure backs up in the casing, because the [135] gas keeps going up, and the pressure is built up to perhaps 100 pounds higher than had been the normal rate, and the effect of that is to force the fluid level down in the annulus. When the well had been pumping long enough you can have a transient effect, so you have an equilibrium condition, the well pumping steadily at the same rate, and the actual fluid level determination has found that it is perhaps 300

(Testimony of Richard W. French, Jr.)

feet lower in the well; in other words, it is 1300 feet, instead of 1000 feet. Therefore, the thing that makes it go down was the pressure change at the surface, and you say that that much pressure change of 100 pounds forced the fluid down 300 feet, and you therefore get an expression of the density. In other words, you force down 300 feet of fluid for 100 pounds, and so you are then able to calculate the average density of that fluid as it actually exists in the well, whether there is water or gas in the fluid.

The Court: How do you know if you only need 100 pounds?

A. You don't know, so what you do is to set back the pressure regulator to build up a certain pressure. You don't know what it is; whether it should be 100 pounds or not. So you see the result you get, and if it isn't enough, you pinch the valve more.

The Court: What if it is too much?

A. It would force the fluid level down to the pump; that is, the pump is getting gas instead of fluid, and you have a gas lock. Perhaps you have had a vapor lock in [136] your car. On hot days we very often get them. The fluid gets so light that you get in effect gas instead of liquid gasoline. It flashes, and turns to vapor, and you simply stop.

The pressures are determined by comparing these two readings; that is, the data that you get at one level, and at the other level. With that same data you also determine the density of the fluid. Ordi-

(Testimony of Richard W. French, Jr.)

narily the density of the fluid level below the fluid surface, the liquid gaseous mixture, was a constant from the fluid level down throughout its length. That is one of the things we learned.

Mr. Fulwider: Q. Can you tell me where you first heard this fact, that the fluid density was a constant irrespective of the depth, for given running conditions?

A. I believe, without being positive about it, that it was through Mr. Walker's discussion at that time that I heard it.

Q. Do you recall whether or not that theory, when you first heard it, was to you a novel theory, or was it contrary to your preconceived ideas?

A. It was contrary. We had not been led to expect that. We were skeptical.

Q. Were your preconceived ideas those that were generally held by those in the oil industry with whom you were acquainted?

A. It is rather difficult to say. I think it is fair to say it was, because all of us missed the boat about the same amount. I was skeptical about the accuracy of this theory until it was [137] proven to me by Mr. Walker. The fact that the density is constant, or substantially constant, accounts for the curve which is plotted between the depth and the pressure being substantially a straight line. That curve is an expression of density.

Q. I call your attention to Figure 3, of patent Re. 21,383. The straight line appearing on Figure

(Testimony of Richard W. French, Jr.)

3 represents density, does it not, that is, the slope of that line.

A. I would prefer to say it plotted a pressure. This one at the right (Plaintiffs' Exhibit 17) does, certainly.

Q. That is the curve, depth of fluid against casinghead pressure? A. Yes.

Mr. Fulwider: May this graph we have been discussing be marked for identification Plaintiffs' Exhibit No. 17?

Q. State whether or not the fact that the line of Exhibit 17 is straight indicates that the density is constant throughout the depth plotted by that time.

A. A straight line signifies a constant density.

Q. That is correct. If the density were not constant then you would get a curve, I assume?

A. That's right.

Q. Prior to Walker's Depthograph method, which you previously described, your preconceived idea was that the relationship on the line that you would get plotting depth versus casinghead pressure, would have been a curve? [138]

A. In general terms, depth against pressure would have resulted in a curved line.

Q. You expected a curve, and Walker got a straight line? A. Yes.

By the Court: How do you account for the fact that it is the same density?

A. Your Honor, it can only be by the fact that we have proof to calculate this. I can't explain it.

(Testimony of Richard W. French, Jr.)

Q. If it were still, and in a tube, it would not be of the same density?

A. No, if it were still, it would be tremendously different. It would not be coming out a solution. There would be a separation. If you have gas coming out of solution, it complicates this.

Q. You say if it were in a steel tube it would be the same density?

A. If it were in a steel tube, and had a chance to overcome the equilibrium; gas coming out like water in a seltzer bottle.

Q. Suppose you had oil, water and mud?

A. In that case you let the well stand long enough to let all these different densities and the constituents separate themselves, as the laws of gravity say they will if given enough time, and you will have gas on top.

Q. Then you have a curve plotting density?

A. Yes, but a very small curvature of gas. [139]

Q. Suppose you take the stuff out of the oil well and put it in a tube and let it stand, the fluid you have, mud, oil, gas, light oil, heavy oil and so forth, would be the same density?

A. It would be the same density in each fluid. The oil would be of the same density; the mud would be heavier.

Q. Where there is fluid, if you plotted that, you would plot a curve?

A. You would have to segregate the oil; then the water; then the heavier mud, and that would

(Testimony of Richard W. French, Jr.)

make a curve, because there are three different densities.

Q. As I understand your position, it is the opinion of those engaged in the production of oil, at least so far as you personally are concerned, and so far as you know, that the same relationship existed in the fluid in the annular spaces of oil wells? A. Yes.

Q. And you discovered that it did not exist?

A. Yes.

Q. Rather, that it still remained of the same density? A. Substantially.

Q. And the mud, or whatever it was, mixed all the way through?

A. Yes, under pumping conditions, it gives in effect a homogeneous mixture. [140]

Mr. Fulwider: Q. Can you tell me whether or not there are any other sonic methods for determining subsurface pressures?

A. There is another method which gives these pressures without pulling the equipment out of the well, and you are perhaps referring to the one that is known as the Echometer.

I think it is generally lumped together, as the general term is "sonic", that is, determining the fluid level by reflection of the obstruction, whether it is sonic, electric or physical.

Q. Would you say, Mr. French, that the development of the Walker depthograph method satisfied any need then existent in the industry?

A. Yes, undoubtedly.

(Testimony of Richard W. French, Jr.)

Q. And, so far as you know, at the time the Walker depthograph method did satisfy this need there was no other satisfactory method for accomplishing the same purpose in pumping wells, so far as you know? A. Yes.

Cross Examination

By Mr. Graham:

Q. Mr. French, this column of oil in the annular space, or this mixture in the annular space between the tubing and the casing, is a static column, isn't it?

A. The mixture of oil and gas, we don't call it a static column. [141]

Q. What do you call it?

A. Static means the measurement of a column of oil and gas taken with the well shut down; not producing; and built up to full pressure.

Q. The liquid does not move in that column?

A. Do you mean when the well is producing?

Q. When it is a pumping well.

A. It may move slightly in some wells. With complete equilibrium, it does not. We have what are called "column-heads" in the wells.

Q. The liquid at the bottom of that annular column doesn't move to the top, does it?

A. Not during ordinary producing operations.

Q. Suppose that oil had water in that column between the pump and the fluid level, what would happen?

A. In other words, you are assuming water in

(Testimony of Richard W. French, Jr.)

the column above the pump, with the fluid level some place above that?

Q. Yes.

A. So far as I know, unless the mixture were a very unusually thick or viscous and heavy one, the water would ordinarily remain below.

Q. So, when you were talking about the density being constant, you simply limited that to a standing column above the pump? [142]

A. No, I can't say I limited it to that, because in my experience we have found substantial gradients, substantial constant density of gradients extending not only to the pump, but below it.

Q. How would you account for that if the conditions are different in a moving column than in a standing column?

A. In some cases the conditions may be different; on the other hand, you have a change in your annular diameter around the pump; you have so many square inches of annulus below the pump.

Q. What effect does the difference in diameter have on the question of determining density?

A. You are measuring, not a stabilized column; you are determining really a combination of gradients; which we need for those three fluids in motion. They may be stabilized, but the gas is bubbling up all the time.

The Court: So long as you operate the pump?

A. Yes.

Q. Or so long as there is movement?

(Testimony of Richard W. French, Jr.)

A. Yes, you are measuring what affects the little fraction of motion there is in that mixture.

Mr. Graham: Q. Prior to the time that you heard of Mr. Walker's apparatus, and the way he used it, you know they did determine density in flowing wells, don't you?

A. Yes, with pressure gauges.

The Court: After you got the density of the fluid in the [143] annular space, how does that compare with the density of the fluid that comes out of the pump? Is it the same?

A. That is where we got the large surprise; it is much less. The gas has been separated from the oil we measure at the surface, that gas, which was present down in the well; where we have to have the gradient, which we don't measure. When we measured the gas from the oil in the tank or surface it caused a much greater divergence than predicted.

Q. Is there any separation of the gas and the oil in its journey from the bottom of the hole to the surface?

A. It may be a continuous separation.

Q. Depending on the depth of the well?

A. Yes, depending upon the depth of the particular type of oil, the temperature of the oil, and normally the gas in solution in different wells has a different amount as it comes out. The journey of the oil from the formation up into the well is one generally of continuous reduced pressure. You get a lot of gas which bubbles out, in most wells.

(Testimony of Richard W. French, Jr.)

Q. So the oil that comes out of the pump, that is no indication of what the density of the fluid is that enters the pump at the bottom of the well?

A. Exactly.

Mr. Graham: Q. Mr. French, on this chart that has been marked Exhibit No. 17 for identification, you will note that the [144] calculations are of depth of fluid against casing pressures?

A. Yes.

Q. Can you take that chart and determine the density from that chart, by taking the figures that are on that chart?

A. I don't think I can. In all cases we have casing head pressure as the abscissa.

Q. Is it possible to get the density from the data on that chart?

A. I think it is possible in some cases. I don't think it is infallible, because your casing head pressure is on the abscissa rather than the pressure at the fluid surface.

Q. Do you think you can do it?

A. In every case?

Q. In this case right here? A. No.

The Court: Is he supposed to be able to do it?

Mr. Graham: He has been telling us what it is.

A. If you will read back the record, when you asked me if that line was an expression of density, I think I put it in these words: "a plot of depth against fluid pressure is density," and the expression, the density in this chart, which is labeled "casing head pressure", there is an indirect step, your

(Testimony of Richard W. French, Jr.)

Honor. You are taking a jump which includes taking the casing head pressure of this well.

The Court: You don't need your instruments?

[145]

A. Just an ordinary pressure gauge.

Q. You have that all the time?

A. That is right.

Mr. Graham: Referring to Figure 3, of Reissue Patent 21,383, from the data on that chart, you can, however, figure the density, can you not, correctly?

A. I will take a look at that. This is the pressure on fluid surface which implies that you can actually measure the fluid level against depth, so I would say that you can calculate the density.

Redirect Examination

By Mr. Mattingly:

Q. In the measurement, in the plotting of these pressures against the fluid levels, you mean if you measure your gas pressures at the casing head, and plot those against your fluid levels, and that is apparently what has been done on 17, is that correct?

A. This is depth of fluid. I was thinking it was just the depth below the ground. That is right. In depth of fluid, it pertains to measurements made at the same periods these casing pressures were taken, and if there were no difference in the gas correction from the casing pressure gauge, at the fluid surface, it would correspond to this chart.

Q. And the gas correction that you have referred

(Testimony of Richard W. French, Jr.)

to, is that something which is known to engineers who would be [146] attempting to find this information? A. Yes, it is common knowledge.

Q. All that the gas correction amounts to is to add this effect in pressure of the weight of the column of gas?

A. To that measured fluid level.

Q. That is a determinable factor?

A. That is right.

Q. You have in your hands the chart, Exhibit No. 17. You have compared that with this chart?

A. Yes.

Q. And you have referred to Figure 3 of patent Re. 21,383.

A. That is right. On looking at that and seeing the depth of the fluid level, and measuring the exhibit 17—I want to correct that, because I have been thinking of this as just well depth against casing pressure, in my former answers to Mr. Graham, as to density. This is, as I pointed out on 17, depth of fluid measured at corresponding times. This is casing head pressure. Then you are able to calculate the average density. It is substantially the same as figure 3.

Q. That is figure 3 of Patent Re. 21,383?

A. Yes.

Mr. Graham: I will ask counsel if Exhibit 17 is supposed to be a reproduction of this figure 2 appearing in the manual which is in evidence as Exhibit 11C. [147]

(Testimony of Richard W. French, Jr.)

Mr. Mattingly. As far as I am able, with my lack of ability, to draw. That chart should appear immediately preceding Page 52 of the manual. I will stipulate that I made Exhibit 17, as an enlargement merely of that figure, without changing any of the values.

Mr. Graham: That is right. The correction I wish to make, your Honor, is this: the witness has called our attention to it. He read that "depth of fluid," and your Honor will look at the chart in the back, Figure 2, where it says: "Depth to fluid."

Mr. Mattingly: May I make that correction? That was the mistake I made in lettering.

Mr. Graham: I will give the witness an opportunity now to correct it. If that chart, Exhibit 17, read; "Depth to fluid," instead of "depth of fluid," then the answers you gave in your direct examination were incorrect?

A. I am afraid I had better refresh myself on the way I answered, I am afraid I might confuse it.

Mr. Graham: I hand you a copy of the page of the manual, and the manual is Exhibit 11C, which is marked, "Determination of sub-surface pressure," figure 2, and which is like this exhibit 17, with the exception of the depth indication, and I call your attention to the fact that on the chart which is here, the measurement is: "Depth to fluid." Can you determine density with the data that appears on that chart, figure 2? [148]

The Court: Density of what?

Mr. Graham: A column of oil or mixture.

(Testimony of Richard W. French, Jr.)

The Court: The density of a column of fluid in the annular space?

Mr. Graham: That is correct.

A. So long as this well was pumping under substantially stable conditions, in other words, had had time to settle down to a steady pumping rate, which we call equilibrium conditions, this data appears to be ample to make calculations of density.

Q. Your answer now is that you can calculate density from that?

A. Yes.

Q. Will you please do it?

A. I don't have my gas correction material here.

Q. That is the point; I am asking you, with the data that is on that chart, whether you can compute the density?

A. If that is the point, Mr. Graham, this density correction. I was just asked whether it was common knowledge to have a correction, to make the computation, and I said "Yes." If that is the point, you can't do it on this chart, because it isn't on this chart. In other words, there is a correction for the density of the column of gas down the tubing.

The Court: It says "gas column" here.

A. Yes, but a gas column pressure, I presume, your Honor, that is from the surface. But you do not have the [149] surface pressure on this chart. The first casing head pressure is on a level of about 3900 feet.

Mr. Graham: Q. To make the calculation you are talking about, you would have to have the den-

(Testimony of Richard W. French, Jr.)

sity of the gas, and the density of the gas isn't on there?

A. No, but the density of gases, although they vary, in my experience, it is not vital. It doesn't prove the accuracy. In my own case, as a gradient for the field I am working in, it may be .65 or .75.

Q. Then your answer is, with the data on that chart, you could not determine density?

A. The best accurate density, no.

Mr. Fulwider: Q. But you can determine the density by merely applying this gas correction factor that you mentioned? A. Yes.

Q. Which is easily available to you from the known data in the field?

A. Yes, as I say, there is an addition here for the column at the present time, but apparently the attention emphasizes on the exact details for that column correction. It doesn't show exactly what column. I would assume it is a complete difference between two fluid levels.

Q. That curve in Figure 2 of Exhibit 11C may be said to determine density in terms of casing head pressure, could it not, rather than fluid surface pressure? [150]

A. Yes, assuming that the gas correction factors are immaterial.

The Court: Is this supposed to indicate whether the fluid level is reduced by the accumulated pumped or increased gas pressure?

Mr. Graham: The casing pressure is increased.

(Testimony of Richard W. French, Jr.)

Mr. Mattingly: According to the instruction book from which that came, the pumping rate is supposed to be constant.

A. Unless you know the data, it may give wrong results. In other words, you have to know that the well is producing steadily. I was assuming that.

Recross Examination

Mr. Graham: Q. If you follow the procedure in which you said you just used a certain gas density for a field, you would not have the accurate results which you have been emphasizing as necessary for the information that you want by conditions in the well, would you?

A. It is just a question of relative accuracy, Mr. Graham. You would not have the ultimate accuracy that you could get, without this small gas correction, but you would have, in my experience, accuracy suitable for our field work.

Q. If I told you that you would find a variation of 15 per cent would you say that was accurate?

A. No. I would say that could occur in cases, but it is [151] one which we ordinarily don't run into in the field where you are familiar with the gas density.

Q. Is there any value in determining the density in the space between the casing and the tubing, except to determine the sub-surface pressure?

A. There may be, but the only thing I am interested in in this case is the pressure.

Q. So far as you know, that is the only value it

(Testimony of Richard W. French, Jr.)

has to determine sub-surface pressures, is that correct?

A. Well, no, I would say there are other inferences, if you want to state it that way, that can be made from some of this data. In other words, the intermediate steps we have to take to get pressure, teaches us something about that, and the density of the mixture of fluid with gas, coming out of solution, it is possible even to get data of the velocity of gas that might be useful in other places.

Q. That is all a matter of conjecture, those different things you say might be?

A. Yes, that is true.

Q. As a matter of fact, in practical use, the only value of determining density is to aid you in determining the sub-surface pressures, isn't that right?

A. Yes, I would say that is true.

Mr. Graham: I think, your Honor, if that chart 17 is [152] going to be used, unless there is some other purpose for having it that way, that it should be made to agree with Figure 2.

Mr. Mattingly: It is stipulated that it may be corrected to correspond with Figure 2 appearing immediately before Page 52 of Exhibit 11C. [153]

CRANFORD P. WALKER

called as a witness on behalf of the plaintiffs, testified as follows:

My residence address is 2874 Carlaris Road, San Marino. I am the Cranford P. Walker named as inventor in the three patents in suit. I graduated from the Bliss Electrical School at Washington; subsequently taught two years there, and then went to Westinghouse and took the course which they gave for graduate engineers, a two-year course. After finishing that they put me in as a teacher on that course. I taught there one semester, and at the same time attended the Carnegie Institute of Technology.

The Court: You graduated from Carnegie?

A. No, I took special work at Carnegie. This work of teaching in the Westinghouse school for graduate engineers was my particular job. There were four of us teaching on different subjects. One was teaching sales, the other was teaching shop management; the other was teaching designing and testing electrical machinery and apparatus, and that latter position is the one that they gave me. I took quite a number of extension courses, but those are the main ones, plus a large amount of home study. When I finished teaching that course I went on as a regular engineer in the general engineering depart- [154] ment of the Westinghouse Company. My duties were primarily determining the size of materials required for driving all sorts of mechanical equipment, from locomotives on down to water well pumps. After that, I did some sales work in

(Testimony of Cranford P. Walker.)

Los Angeles; I was transferred to the Los Angeles office of the Westinghouse Company, and then went to work for the Llewellyn Iron Works, primarily consisting in the laying out of a steel mill at Torrance. My work was mostly to do with the electrical equipment. It was an all-electric steel mill. I was associated with the Llewellyn Iron Works from early in 1916 until about the middle of 1935. That covered a period in there with the Consolidated Steel Corporation, successors to the Llewellyn Iron Works. After I severed my connections with the Consolidated Steel Corporation in 1935, I was doing general consulting engineering work; mechanical and electrical.

Mr. Mattingly: Will you give the court as briefly as possible the history of the development of the apparatus for determining fluid levels, the methods that you have devised for determining fluid levels, and the method you have devised for obtaining the pressures in the fluid column, densities in fluid columns and production capacities of wells, as described in your three patents which are in suit in this case?

A. In September, 1935, I was told of this method which two Shell engineers, Wyatt and Lehr, had for determining [155] fluid levels in pumping oil wells, and on October 3rd, I went to Ventura to see their equipment demonstrated, and I decided to take on the job of developing suitable equipment for making records of echoes which were received from the fluid level in the well.

(Testimony of Cranford P. Walker.)

The equipment that was demonstrated to me by Lehr and Wyatt at that time was a crude home-made affair, consisting of an ordinary oxygen bottle containing probably 800 cubic inches, in which they stored gas at whatever pressure they had available from some well, at which they obtained the gas. This bottle was connected to a smaller container, about three inches in diameter, probably a foot long, which they filled with gas from the larger container, and the amount of pressure that was put in that container depended upon the depth of the well and the size of the casing. I think I saw it demonstrated from probably 100 pounds up to 500 pounds, in that container. At my request we had that changed over these lengths, to see what happened. They discharged the gas by means of a quick-opening valve, into the well, and the opposite side of the casing from which they were connected was opened to the air. The well had no pressure on it. By means of a stop watch, from the start, at the time the gas was discharged into the well, they held their hand opposite the opening, and as soon as they felt a puff, and heard it coming back they snapped the watch, [156] and from then on they told you roughly what the fluid level was; what the distance of the fluid level was, and just what velocity that was. It was primarily a demonstration of the equipment that they had.

The equipment they had consisted of a bottle of stored gas, a chamber into which they would let a

(Testimony of Cranford P. Walker.)

quantity of that gas, a quick-opening valve to let the gas go into the well, a stop watch and the hand of the person who held it over the opening in the casinghead, to attempt to feel the impulse as it came back.

Q. Is that the apparatus which is illustrated in Figure 1 of the Lehr and Wyatt patent, which has been referred to in this case?

A. Yes. The equipment which that demonstrates was substantially the same as that shown in Figure 1 of the Wyatt and Lehr patent 2,047,794.

[Printer's Note: Plaintiffs' Exhibit No. 18 is set out in full in the Book of Exhibits.]

Q. At the time of this demonstration to you on October 3, 1935 did Lehr and Wyatt demonstrate to you any apparatus in accordance with Figure 2 of the Lehr and Wyatt patent that we have just referred to?

A. No. There was no recording apparatus connecting the apparatus which they demonstrated to me.

Q. When you say that you decided to take on the job of developing—I believe you were going to take on the job of developing apparatus for the practice of the Lehr and Wyatt [157] method; is that correct? A. Yes, sir.

Q. What did you do as a result of that decision?

A. I think for the balance of October, I spent practically all of that time investigating the various devices on the market, microphones, amplifiers

(Testimony of Cranford P. Walker.)

and electric recording devices, but was unable to find any that I considered of sufficient speed as a recorder and of the proper type as an amplifier. I had had considerable experience with recorders such as shown in Figure 2 of the Wyatt and Lehr patent, both at Westinghouse, primarily in connection with the test of high speed elevators, and here in Los Angeles I was in charge of the Electrical and Mechanical Department of the Llewellyn Iron Works where we developed the variable voltage elevator on the Pacific Coast. As I said, we did a large amount of testing of those elevators while operating at high speed, and those elevators require very fast instruments for recording the performance of the voltage, amperage and acceleration; but at that time I was not able to find any that had sufficient speed to keep up with the changes in those circuits, the changes of current and voltage and acceleration, except an electric oscillograph. So I had the same experience a little later when I was trying to find something to record the echoes and which would have speed enough to record them properly, according to my ideas.

Q. Did you attempt to assemble any apparatus with the Lehr and Wyatt gas bottle and gas chamber and quick-opening [158] valve for the purpose of making a record of the echoes which were received back from the well?

A. Yes. In November I assembled two different types of microphones, an amplifier and an oscillograph, and experimented with those on a shallow

(Testimony of Cranford P. Walker.)

well at Signal Hill. That was the Cosboom No. 1 well. On these tests I used a carbon microphone known as a type A, made by the Universal Microphone Co. of Inglewood; also a dynamic type of microphone, which is a microphone with a moving coil attached to the diaphragm, which coil moves in a magnetic field as the diaphragm is actuated by pressure waves or sound waves. The recording instrument was a Westinghouse Electric oscillograph, which makes a record on a photographic film which can be removed from the oscillograph.

Q. Do you have any copies of the films or records which were made on that well at Signal Hill with that apparatus you have just described?

A. Yes. I was able to find two of them.

Q. Mr. Walker, just before the end of the morning session I asked you whether you had any charts which had been produced by the apparatus which you assembled together, including the electrical microphone and the electrical oscillograph, which you used in an attempt to practice the method of the Lehr and Wyatt patent. Do you have these charts?

A. Yes. The one marked Film No. 2 of November 19th, 1935, [159] was made with a carbon microphone and an amplifier and an oscillograph, on well called Cosboom No. 1 for the Shell Oil Company, that I referred to in my testimony this morning.

Mr. Mattingly: At this time I offer in evidence chart just produced by the witness as Plaintiffs' Exhibit— —

(Testimony of Cranford P. Walker.)

The Court: Plaintiffs' Exhibit 19. These are reproductions of the original chart; is that right?

Mr. Mattingly: That is correct, your Honor.

The Court: It is stipulated that the copies may be used.

[Printer's Note: Plaintiffs' Exhibit No. 19 is set out in full in the Book of Exhibits.]

Mr. Mattingly: Q. You have produced another record chart. Will you identify that, please?

A. That original film was marked Film No. 1, November 20, 1935, and was made by using a dynamic type of microphone on Cosboom No. 1 on Signal Hill, a dynamic type of microphone and the same amplifier, which is known as a cardiac—that is, an amplifier that would respond to low frequencies for measuring heart beats and pulse action.

Mr. Mattingly: At this time I offer in evidence the record chart just produced by the witness, dated November 20, 1935, as Plaintiffs' Exhibit No. 20.

[Printer's Note: Plaintiffs' Exhibit No. 20 is set out in full in the Book of Exhibits.]

The Court: Where is the beginning and the ending?

The Witness: The beginning is to the left.

The Court: I see. There are three exposures here.

The Witness: Three exposures, yes, and those indicate [160] something that was coming from the well. The complete record is supposed to be on the left-hand end, but the shutter was closed and we

(Testimony of Cranford P. Walker.)

didn't get the start on that; just got the other three there; just got the echoes that came back.

The Court: Exposure No. 1 was a blank?

A. Yes.

The Court: So 2, 3 and 4 on No. 19 are exposures produced immediately after one another; is that right?

A. Yes, in succession as they are numbered.

By Mr. Mattingly: Q. Referring to Plaintiffs' Exhibit 19, will you explain what is shown on that chart with reference to the injection of the gas slug into the well and any echoes which may have returned from the portion of the wall on which you were testing?

A. The record of the injection of the gas slug is not shown there. As I said before, the shutter happened to be closed and we missed that. But the following exposures, No. 2 and 3 and No. 4 were the return echoes. That is what we were trying to pick up, were the return echoes. We were not particularly interested in the record of the release of the gas.

The Court: You have one marked here No. 4, of Exhibit 19, "gas released."

A. That is right, your Honor. That No. 4 is the release of the gas. The first splash on that record there is gas released [161]

Mr. Graham: May I ask which end he is starting at, the left or right?

The Court: He is starting at the left, but he said that the films here did not indicate any release of the gas. No. 2 and 3 do not indicate that?

(Testimony of Cranford P. Walker.)

A. 2 and 3 do not indicate the release of the gas. We missed it on the first one, so on No. 4 we got the release of the gas.

The Court: That is, you did it over again?

A. Yes. 2 and 3 are the return echoes, and No. 4 when we released the gas. The first disturbance shown is when the valve retaining the gas in that bottle was opened and was discharged into the casing of the well. The next major disturbances on there is when the protecting valve, which is immediately ahead of our microphone, to keep from injuring the microphone when the gas is discharged into the well—that second disturbance is when that protecting valve was opened to make the diaphragm microphone sensitive to pick up the return echoes.

That is the second disturbance.

The Court: That is the fourth disturbance on this film, the way I count.

A. I referred to it as the second major disturbance, your Honor. It is the second disturbance.

The Court: No. 1, then the next little jiggle is No. 2, [162] and the next is 3 and the next is 4.

Mr. Mattingly: No. 2 would be the major disturbance that the witness has just been referring to.

The Court: It says there "Valve to mike opened." Now, start at the beginning, the "gas released."

A. "Gas released" is now marked No. 1.

The Court: Now, what is No. 2.

A. I don't know what No. 2 is. Neither do I know what No. 3 is. We frequently had gas dis-

(Testimony of Cranford P. Walker.)

turbances which came from the bottom of the hole, which are interspersed anywhere along here. So that is probably a burst of gas from the fluid that caused this disturbance.

By Mr. Mattingly:

Q. Do any of the markings or wiggles on that line indicate the reflections from obstructions in the well, as far as you can tell from that record?

A. Well, I think that on exposure No. 2 there are two disturbances, and we know those are repeated on exposure No. 3. I concluded that that came from something in the well, but I don't know what they were from.

Q. You could not identify it as being a tube collar or tube catcher or fluid level?

A. No.

Q. Or any particular kind of an obstruction in that well? A. No.

The Court: See if I understand what he did here. You introduced that pressure impulse? [163]

A. That is right.

The Court: And the first exposure was closed?

A. That is correct.

The Court: How did you get No. 2 and No. 3, just leave the camera on, or whatever you call it, the oscillograph?

A. Those blueprints——

The Court: Well, these were reverberations; is that right?

A. Those blueprints represent the length of a

(Testimony of Cranford P. Walker.)

standard kodak film, and we wanted to get as many of the significant points or reflections on it as we could. So we didn't let it run continuously from the time the wave started down until it came back. And on exposures No. 2 and No. 3 we started the film just in time to catch the return echoes.

The Court: Only the return echoes?

A. The return echoes.

The Court: You didn't get the——

A. We didn't get the start.

The Court: Well, that's all you ever get, is the return echo, isn't it?

A. Well, we record the start when it starts down, as we did on this exposure No. 4. Then we start the film before we reach the gas. We ran out of film before the echoes came back on that one.

The Court: On No. 4? A. Yes. [164]

The Court: All these, clear to the end of No. 4, are just the sounds going down or the sounds bouncing back?

A. That is No. 1.

The Court: No. 4.

A. The disturbance No. 1 on exposure No. 4 was when this gas was discharged into the oil well. Then very soon thereafter we opened the valve to expose the microphone—We had a by-pass around the microphone, which permitted us to make a record of this release of the gas—a restricted by-pass. Then we immediately opened the valve, opened up the well right into the microphone, which is shown as disturbance No. 4 on exposure No. 4. Up to that

(Testimony of Cranford P. Walker.)

time there was a quarter inch pipe with a needle valve in it, which permitted the disturbances to come from the well and be recorded on the film.

The Court: And between 1 and 4, as I understand are reverberations from the well? These are just the sounds from the introduction of the impulse?

A. Well, those disturbances could be from the well, and most likely were.

The Court: Where did you measure the depth of the fluid?

A. That isn't recorded. We ran out of film before those echoes came back. We had really been trying to record those echoes on exposures 2 and 3. We didn't start the camera until the time we expected those echoes to reach the surface, or just a little ahead of that time. [165]

The Court: The non exposure No. 2, this first disturbance, the one to the left——

A. That is an echo from the well.

The Court: That is an echo from the fluid level?

A. Well, I don't think it is the fluid level. It is something in the well.

The Court: What is the next one?

A. That was another obstruction in the well. I imagine the first one was a catcher, probably, and the second was a liner top.

The Court: All right.

A. The fluid level I don't think is shown.

The Court: You don't think the fluid level is shown?

A. No.

(Testimony of Cranford P. Walker.)

Mr. Mattingly: Q. To get the record straight, on the left-hand end of this chart, Exhibit 19, is a piece of film which was not exposed because the shutter of the camera was not open during the time of making that chart; is that correct?

A. That is correct.

Q. Then the next one, marked exposure No. 2, is the part of the film which was exposed but which was started to be exposed after your second impulse had been introduced into the well?

A. Yes.

Q. And exposure No. 3 is the portion of the film which was exposed during a third test, and again this film was started after the third impulse had been injected into the well? [166]

A. Yes.

Q. And exposure No. 4 is that part of the film on which was recorded a complete operation, and in that case the film was started just before the fourth impulse was injected into the well?

A. Yes, that is correct, except it isn't a complete operation. Take film No. 2, for instance, and just tack it onto the end of—if exposure No. 2 were placed at the end of No. 4 you would have a complete record, the start of the impulse, as well as the return echoes from that impulse. The camera held such a small quantity of film that we wanted to get as many reflections as we could.

The Court: Is that the original film there?

A. Yes.

(Testimony of Cranford P. Walker.)

The Court: Let me see it. Will it injure it?

A. No. (Handing film to the Court.)

The Court. Then you attached these together?

A. No, they are not attached together, your Honor. That is a standard length. I believe that is a six exposure Eastman film. Those markings are just where we stopped the camera.

Mr. Mattingly: Q. Mr. Walker, would you explain to the Court what is shown on the record strip, Plaintiffs' Exhibit 20?

A. That is similar to Exhibit 19, except I was using a dynamic type microphone, the same amplifier and same recorder, that is an electric oscillator, as I used for making the record [167] known as Exhibit No. 19. In that film it looks like something happened. We missed the first shot, because there is quite a blank on the end of it on the left. And the first record on that film is not marked, but it looks like the echoes of something.

Q. Would you put a bracket about those parts that you are just referring to, and mark that "A"? Does that record show any complete record showing the putting of the impulse into the well and the recording of echoes back from the well?

A. It shows one or the other, but I don't see which it is.

Q. I mean anywhere on that record strip, which you have just produced as Exhibit 20, is there shown any complete recording of the firing of the shot and the return back of a series of echoes from the well?

(Testimony of Cranford P. Walker.)

A. Yes. The exposure on the right-hand end, which is about the right-hand half of the record, is a complete——

The Court: Well, let's identify that some way. Mark on there with a bracket and call it—that is exposure No. 3 on this film, isn't it?

A. It appears to be.

The Court: All right. Mark that exposure No. 3 on Exhibit 20. That is your first complete record?

A. That is the first complete record.

Mr. Mattingly: Q. On that record will you identify the recordings which indicate the injection of the impulses into the well? [168]

A. The first disturbance, I would say, is the injection of gas into the well, which we will mark No. 1. The next disturbance, which is of a longer duration, is where the protecting valve was opened; and I will mark it No. 2. There is a disturbance following that immediately. I don't know what that is. We can identify it as No. 3. Then there is a tiny disturbance half way down to the next major disturbance, which is probably a gas disturbance or it may have been something in the well. Then we come to a major disturbance which lasted for about almost two inches on this record. We can number that No. 5. And then about three inches from where that started there is another disturbance——

The Court: What is No. 5?

A. I don't know what that is.

(Testimony of Cranford P. Walker.)

The Court: Could that be the fluid level?

A. No, that is not the fluid level. That most likely is gas breaking through the fluid surface. As far as the actual records go, I don't believe there is anything shown at that point. And about three inches from that No. 5 large disturbance is a small disturbance there. For the purpose of identification we will call that No. 6.

Mr. Mattingly: Q. Do you know what that disturbance was?

A. No. That is an extraneous disturbance that we don't know why it occurred. There is another little disturbance [169] there. I suppose we should call that No. 7.

The Court: Let's see which one you are calling 7.

A. That is about an inch from No. 6, your Honor. About an inch. The light spot was thrown so far it didn't record there for a fraction of a second. The next disturbance is about three inches from No. 7, and lasted for about half an inch on the record. I am numbering that No. 8.

Mr. Mattingly: Q. Do you know what that disturbance was caused by?

A. No, I don't know what that came from. Then there is another little disturbance a little over an inch from No. 8. We will call it No. 9. And about three-quarters of an inch farther aong is another disturbance; No. 10; and those, I think, are from a catcher or liner top, but they were not distinct enough to be sure just what they are from.

(Testimony of Cranford P. Walker.)

Q. Is there any reflection from the fluid level shown on this chart, No. 20?

A. I don't think so.

Q. Could you, from the records which were made at that time and copies of which you have produced here, have determined the location of the tube catcher and the liner top with respect to the location of the fluid level?

A. W were not able to locate any that we were sure of.

Q. Do you have any other records that were made with an electrical oscillograph and microphone equipment that you [170] testified about this morning? A. No.

Q. What did you do after you made the two records, Exhibits 19 and 20, with respect to attempting to assemble or use apparatus for the purpose of making these fluid level determinations?

A. The result of those tests was so unsatisfactory that I immediately began the construction of an experimental—what I will refer to as a diaphragm type of receiver, which was a diaphragm which the pressure waves would impinge. Attached to that diaphragm and actuated by it we placed a tiny mirror, which took the place of the mirror in the electric oscillograph, which was electrically operated. This mirror was operated mechanically instead of electrically. I used practically the same optical system as that in the oscillograph, a tiny light shining on the mirror and light reflected from the mirror through an optical system onto the photo field.

(Testimony of Cranford P. Walker.)

On December 12, 1935, we had that equipmer finished and took it to this same well, that is, Co boom No. 1 at Signal Hill, and tried it out. I hav here film No. 2, made with that equipment at Co boom No. 1 well, of the Shell Oil Company on Sig nal Hill, on December 12, 1935.

Mr. Mattingly: I offer the chart just produce as Plaintiffs' Exhibit 21. Will you explain wha is recorded on [171] this record, Exhibit 21, whic you have just produced?

[Printer's Note: Plaintiffs' Exhibit No. 2 is set out in full in the Book of Exhibits.]

A. The first break in the light line on that cha is the release of the gas from what we call the im pulse chamber. That is where we stored our ga preliminary to discharging it into the well casing It is marked "Gas Released". The next break i the light line is where the valve protecting th diaphragm was opened, exposing the instrumer through the two-inch pipe to the well. Previous t that time the diaphragm had been exposed to th well through a quarter-inch pipe with a needle valv in it. And about four inches farther along fro that break in the line there is a disturbance, whic isn't identified. Shall I identify it?

The Court: Well, you had better start with "Ga released" as one; "Valve to recorder opened", a No. 2; the next disturbance as No. 3, and so on.

A. No. 3 is the one that is about three-quarter of an inch long.

(Testimony of Cranford P. Walker.)

The Court: The big one? A. Yes.

Mr. Mattingly: Q. Do you know what that disturbance was caused by?

A. No. Then the next complete break in the line is a little over three inches from the disturbance No. 3, and it is marked "Echo from obstruction". I will mark it No. 4. The [172] next break in the line is marked "Main echo". I will mark that No. 5. At the time those were made I didn't know what that "Echo from obstruction" or the "Main echo" was from. But I think when we got the well records a few months later, that "Main echo" was the liner top. The Shell Oil Company maintains those well records. Those records that are kept by the oil companies show the location of the liner top, the pump, and try to keep a record of the location of the tube catcher, but they can't always depend upon it because the field men don't always turn it in accurately, and sometimes don't turn in the change at all.

Q. How do they get those records?

A. The men who pull the tubing out of the wells—perhaps I should start on the casing first. When a well is drilled they keep a complete log of every foot of pipe that goes into the hole, and from that log any change in the size of the pipe can be determined. And the liner, of course, is usually smaller than the pipe above it, because it is installed through the pipe up above it and is usually perforated and is what they call a screen

(Testimony of Cranford P. Walker.)

pipe. Then when they run the tubing in they keep a tally sheet of the tubing that is run into the well, the number of stands, the number or joints per stand, and location of the catchers and the total tubing in the well, which, of course, gives them the location of the pump.

The Court: That "Main echo" was a tube catcher, you say. [173]

A. The "Main echo", I think on that one, is the top of the liner, which is smaller and constitutes a restriction in the well, which would produce a reflection.

The Court: Well, that liner is where the size of the well is reduced, isn't it?

A. Yes. And any change in the size, either an increase or a decrease, causes a reflection and is recorded.

The Court: Does that show a reflection from the fluid?

A. I don't believe the fluid reflection shows on that one.

The Court: That isn't the complete record, then, is it?

A. There is nothing shown farther on down. The fluid was down inside this liner, some place, and it isn't always easy to obtain reflections, from the fluid level when so much of the energy is reflected back from the top of the liner; besides, so much of that energy goes out through the perforations and is lost and never comes back; so it is

(Testimony of Cranford P. Walker.)

difficult to get reflection from the fluid when it is down inside of the liner.

Mr. Mattingly: Q. Do you know whether there was tubing in that well at the time you made that test, Exhibit No. 21?

A. There was tubing in that well and it was producing at the time of the test. The pump was operating during the time we were making the test.

Q. Could you, from an inspection of that record, Exhibit 21, determine how many lengths of tubing there are in that well? [174] A. No.

Q. Will you explain to the Court why it is that when you were trying to select this equipment that you selected and tried out a carbon type of microphone and a dynamic type of microphone and why you didn't select perhaps another type of microphone?

A. There did not appear to be any other type of microphone that would meet the requirements at all. I wanted a microphone that would show the magnitude of the reflection, the duration of the reflection and the direction, so we could interpret the reflection we got. I tried to get a reproduction of the microphone which would produce all the irregularities inside of the well-casing, in the annulus.

Q. Did you attempt to use the hot wire microphone?

A. No, I did not think it possessed the proper characteristics. It had no directional properties.

(Testimony of Cranford P. Walker.)

A crystal type of microphone appeared to be about the best type, but it does not function when it gets above 130° F. In the San Joaquin Valley, if the microphone is placed in a black pipe, the pipe sometimes gets up to 150° so the microphone would be useless, the crystal type would be rendered useless before it got up to that high temperature. The crystal microphone has directional properties, because it is the same as the carbon. The dynamic microphone hasn't any proper properties and is not suitable for low frequencies.

Q. Explain what you mean by a directional properties [175] in a microphone.

A. One type of microphone, when an impulse encounters a constriction in the pipe, a pressure wave is reflected and the microphone should show a recording device moving in one direction. When it strikes a perforation where the hole gets larger, we wanted something to show the fact that it had struck an enlargement, and that light beam or record element would move in an opposite direction.

Q. Does a hot wire microphone have the property of distinguishing between a constriction in the well and an enlargement in the well?

A. It does not.

By the Court: Did you find a microphone that when it hit one type of construction would do one way, and if it hit another type would record on the other side? As I understood your testimony that was what you were looking for.

(Testimony of Cranford P. Walker.)

A. That was what I was looking for. I did not find a satisfactory one. The carbon microphone was the nearest we could come to it, but it wasn't practical, because when exposed to wet gas the crystal has an affinity to wet gas and it would put it out of commission. I don't know anything yet that is satisfactory in the way of an electric microphone.

Q. A hot wire is not? A. It is not.

Q. Did not the apparatus work here the other day? [176]

A. It will show single reflections all right. In Kansas wells are quite simple; they run about 3300 feet deep on the average, with nothing to interfere but the fluid level, so the hot wire microphone worked all right under conditions of that kind. And the daddy of that outfit got confidential, one time, and admitted that his hot wire was not suitable for California conditions.

Mr. Mattingly: Q. By the directional characteristics of that microphone, in your explanation to the Court, did I understand you mean, in making a graph with a non-directional microphone, such as a hot wire microphone, the record, for example, of the tubing catcher would show part of that reflection extending in two directions; for example toward the right, viewed on the drawing of patent 2,156,519 and then, if the wave encountered an enlargement, such as a perforation or hole in the casing of the well, then it would also show a break in the line, the start of which also would be to the right.

(Testimony of Cranford P. Walker.)

A. That is true of the hot wire microphone, and any other non-directional microphone.

Q. Then these two types of obstructions, one of which constricts, and the other an enlargement; would be registered by the hot wire microphone as though they were both constrictions, is that right?

A. That is right, under California conditions, and [177] in South Texas, I believe, but at any rate it is true in California. We have a large number of reflections from many of the wells, and if we are not able to identify those by the direction in which they are recorded, we are just lost in a maze; we don't know which is the fluid level.

The Court: A hot wire microphone would record those obstructions in the well. What about tubing collars? Does the hot wire microphone record those regularly? A. I understand it does.

Q. What about your microphone?

A. It records them frequently and regularly.

Q. And to the right and left—I say right and left; I am looking at this vertically. So that the tubing collar markings are on a theoretical center line, either on one side of the line of these variations in the line or on the other side?

A. That is correct, although that is not so very important in the recordings of tubing collars. Then when you come down to some other obstruction in the well, say when you hit a liner, for instance, you get one kind of a marking on this record, and when you hit some other kind of an obstruction or constriction, the deflection is in the same direction

(Testimony of Cranford P. Walker.)

as when a wave encounters any constriction in the well. A narrowing down or obstacle, or partial obstacle, reflects a wave, which is a pressure wave, but if it runs into an enlargement of the path it is traveling, the [178] annular space, it creates a slight vacuum called a rarefaction. Tubing collars are constrictions of the annular space.

Q. Then where do you fi d the enlargement?

A. The well bore at th. bottom is usually larger than the screen pipe that is set into the bore, and there is usually a section of that pipe that is not perforated, from 10 to a hundred feet or more, between the liner top, until you get down to the producing horizon, where the perforations start; that is smaller than the bore.

The Court: Smaller than the well, your hole in the ground?

A. It is small, so the wave cannot travel in the bore. It is confined to the pipe. After it passes the liner top, the area of the annulus, frequently, roughly is half of the area of the annulus bore to that of the liner, but the space where the bore is the same all the way down and is large enough to accommodate the large pipe above the top of the liner, when it strikes the constriction, the pressure wave is reflected back, but as soon as it reaches a point where the perforations begin it is again able to get outside of the liner, and travel in the space behind the liner or a cross section area.

The Court: I think you had better take a piece of chalk, and make a diagram for me. You have

(Testimony of Cranford P. Walker.)

marked "bore". Normally that is outside of the well-casing?

A. In other words, ordinarily there is no casing. You have [179] no hole that is of uniform diameter all the way down. They sometimes change bits, and bore a smaller hole, but when they reach the top of the oil sand they run the pipe in, which is called the water string. I will mark it "casing"; and that is cemented at the top of the oil sand and then they run in a perforated pipe, called the "liner".

Q. That goes all the way through, however, doesn't it?

A. No, it just goes to the top of the oil sand. There is no particular object in having it all the way up. The reason for that is, so that you can cement off the hole and prevent surface water from coming down and getting into the oil sand, so that pipe of a smaller diameter, or a combination which is frequently used on the water string is a casing of 8 and 5/8ths, with a liner of 6 5/8ths, and a 2½ inch tubing changes the area of that annular space. It is about 40 inches across, this section of the area here, and it drops down about 21 inches here, so it cuts the annual space in half. So you get quite a reflection of the wave out of the liner, but when the wave hits the point where the perforations occur, it has the area between the tubing and the liner and the well bore, which brings it back to 40 square inches again.

Q. The fluid level is above the top of the liner?

A. Just the one reflection. When that wave hits

(Testimony of Cranford P. Walker.)

an enlargement it reflects a wave rarefaction, and that should [180] record in the opposite direction from which this pressure wave record would occur when you hit the top of the liner. So it should be recorded, to know it is not a fluid level.

Q. You get the same kind of a reflection from the top of your liner that you get from your tubing collar?

A. Yes, or the fluid level if it were there. Then when we hit these perforations, we got back in the larger area, and a wave, sometimes quite a strong one, of rarefaction or partial vacuum, is reflected to the top,—which gives a different kind,—in the opposite direction on the chart.

Q. And the microphone is the thing that selects it? A. That is correct.

Q. Have you got any of these rarefaction waves on your chart? You have a chart here which is exhibit No. 4.

A. There are none shown in that chart.

Mr. Mattingly: Q. Mr. Walker, will you draw us a line indicating on the chart how it would record the pressure wave from the constriction in the well.

The Court: Just draw it, and put a tubing collar up there in your tubing.

A. I will start this off. That is where the discharge is, really. When you hit the tubing collar you get a slight reflection.

The Court: Only one to the right. Do you only get one?

(Testimony of Cranford P. Walker.)

A. I am drawing it to correspond with this picture.

Q. I understand, but I am asking you if when you [181] hit the tubing collar you only get the one?

A. One to the right. They are so close together that they almost overlap. It is just a continuous train of waves and sometimes they are just peaks. When you strike this liner top you get quite a large reflection. It shows the fluid level down inside of the liner, but almost at the pump, so when we hit the fluid level, and you have a shale break, or something caves in behind the liner at that point, when you hit that, you get another of these.

Q. In the same direction as the tubing collar?

A. In the same direction. When we hit the fluid level you get another one, so if these are not, all of them, in their proper direction you can get entirely lost in trying to interpret it.

Q. And these that are on the drawing or patent 2,156,519, you will see C and D—in Fig. 3, goes first to the right, and then across the line to the left.

A. Sometimes, if the instrument is not adjusted properly, it will swing some little distance. That is just an overshooting of the instrument, but it is the longer arm of the two that gives the information we seek.

Q. What kind of a wave do you call this?

A. A rarefaction.

(Testimony of Cranford P. Walker.)

Q. These are pressure waves and the others rarefaction waves?

A. Yes. A rarefaction wave is a vacuum, or a partial vacuum. If you place two pieces of cardboard together, and suddenly [132] separate them, a partial vacuum is created between those two pieces of paper. That is the zone rarefaction, as compared with air pressure.

Q. In other words, it blows until you get down to where the other sucks.

A. It pushes until it gets down there to the larger space, and it causes a suction, causes a rarefaction.

Q. In other words, the sound travels by these holes, and creates suction?

A. No, it runs into the larger space, where it travels more easily; there is less resistance, where it tends to jump ahead a little bit.

Mr. Mattingly: Q. I made a copy of the drawing which appears on the board, which has just been made by the witness.

The Court: Will counsel stipulate that it is a reasonable facsimile?

Mr. Graham: Yes, your Honor.

Mr. Mattingly: I offer that in evidence as Plaintiffs' Exhibit No. 22.

[Printer's Note: Plaintiffs' Exhibit No. 22 is set out in full in the Book of Exhibits.]

Mr. Graham: It is merely illustrative of the witness' testimony.

(Testimony of Cranford P. Walker.)

Mr. Mattingly: At this time, your Honor, I believe we have the Exhibit No. 17 identified which I will at this time offer in evidence as Plaintiffs' Exhibit No. 17.

The Court: Has that been corrected? [183]

Mr. Mattingly: Yes, it has been. I offer that in evidence as Plaintiffs' Exhibit No. 17.

(Exhibit 17 is not in this record. It is the same as Fig. 2 of Exhibit 11C.)

The Court: It may be admitted. Before we go on to the next thing, let us go back to "rarefaction". What kind of a microphone is it that you say records these different waves in a different manner?

A. About the only one would be a carbon microphone or the crystal microphone, neither of which is suitable for that type of service.

Q. Is that what you use now in your equipment?

A. No, we use a diaphragm which actuates a mirror direct; there is nothing electrical.

Q. Mark "22" on the blackboard then. Exhibit 22 is a diagram explanatory of what you desired, is that right. A. That is correct.

Q. How did you know what you desired when you did not know anything about these pressures in the back of the well? In back of the perforations, etc.

A. It was just a part of my training. I wanted to have everything as near exact as possible, and to give an exact reproduction of whatever was in there.

(Testimony of Cranford P. Walker.)

Q. Does the present diaphragm and mirror arrangement respond [184] like the microphone that would record these different waves? A. Yes.

Q. It gives the same differences then?

A. The same differences, yes.

Q. A hot wire microphone will not do that?

A. Not that I have any knowledge of.

Q. All right. Is this a matter of common knowledge, or is this a matter upon which you claim invention or discovery? What is your position?

Mr. Mattingly: That is not a point which is really in issue in this case, your Honor. That evidence was brought out merely to show——

The Court: It is one that goes to the method?

Mr. Mattingly: Not exactly. It was brought out primarily for the purpose of showing what was available at the time Mr. Walker entered this field for development; what was available to him in his apparatus.

Q. The point is that this apparatus was available to him.

Mr. Mattingly: That is correct. Immediately following the period in which you employed the apparatus and made Plaintiffs' Exhibit No. 21, will you state what you did, Mr. Walker?

A. I immediately began designing a commercial unit which would work like the temporary test unit with which the record, Exhibit No. 21, was made. I completed the commercial unit I [185] started at that time. It was first used on March 6th, 1936,

(Testimony of Cranford P. Walker.)

in testing a well of the Shell Oil Co. in the Signal Hill field, and the particular well was Alimitos No. 39.

Q. Will you please explain what the type of apparatus was that you completed as a commercial apparatus and state whether or not that apparatus is diagrammatically illustrated in the drawing of patent 2,156,519.

A. That is, with the exception of the adjustable nipple shown as No. 19 on that exhibit. The apparatus which I used on March 6, 1936, also included the part which has been referred to here as the calibrating tube and which is identified by the characters 53 to 67 on the drawing of patent 2,156,519. That was part of the equipment that we deemed very desirable to make. Mr. Wyatt had told us that although this patent teaches the method of determining the velocity at which sound wave travels in the gas in the well, that that was not at all dependable. That method involves taking a sample of the gas, measuring its velocity, and from the gravity determining the theoretical velocity at which the wave would travel in the gas. They had to make a temperature correction; had to assume a temperature of this gas column, so he said that they frequently got fluid levels way below the bottom of the well, and he strongly recommended devising something that would give more accurate results than timing the velocity from which to determine the fluid level; and the design of that equipment was started about the same time [186]

(Testimony of Cranford P. Walker.)

as I designed the receiving and recording apparatus shown in that exhibit were started.

The Court: The echoes or sound that you recorded and counted—what was it?

A. It is a form of sound wave. A sound wave is a pressure wave.

Mr. Mattingly: I believe you said that you commercially used this machine to make a test about March 6, 1936. Did you keep a copy of the records that you made at that time?

A. Yes; I found one.

Q. I show you a copy of a chart which was marked during the taking of the depositions as Defendant's Exhibit D-4, and ask you if that is the record that you refer to?

A. That is the record.

Mr. Mattingly: I offer the record just identified by the witness as Plaintiffs' Exhibit No. 23.

[Printer's Note: Plaintiffs' Exhibit No. 23 is set out in full in the Book of Exhibits.]

Mr. Walker, will you look at the chart, Exhibit No. 23, and explain briefly to the court what is represented on that chart?

A. About two inches from the left-hand end of the chart, the dark black line is broken, and a thin line extends on toward the top of the chart. That is the point where the gas was discharged into the well to create the impulse. That is point No. 1. It is the indication of the pressure impulse. It has [187] quite a long indication, from the time

(Testimony of Cranford P. Walker.)

it got back onto the track. The protecting valve was open. It is in front of the diaphragm, to prevent it from being injured by the shock of the pressure impulse.

Q. That valve is No. 21, on the drawing of patent 2,156,519, will you continue, Mr. Walker?

A. That light beam gets back onto the center of the chart, or near the center at 2. That is about nine spaces on the time scale from the beginning of the record; since there was no tubing in that well, I don't know just what these oscillations were due to, and there is nothing of significance until we get down within about 7 inches of the end of the chart; there is a deflection which I mark 3 toward the top of the chart, or toward the time scale. Those are one-tenth of a second marks, the small ones; the major marks on the time scale, the major diamonds are one second apart. Then there doesn't appear to be anything else until you get close to the end of the chart, where the echo from the fluid level is recorded, which I mark 4. It is actually 7.26 seconds from No. 1 point.

Q. What did you do with this apparatus, this commercial apparatus, with which you made chart, Exhibit No. 23, subsequent to this first commercial test on March 6, 1936?

A. On March 7th we made another test, two or three of them, I suppose, but I know we made one more test, and that was [188] on a well belonging to the Shell Oil Company known as Nesa No. 1 on

(Testimony of Cranford P. Walker.)

Signal Hill. Incidentally, this Exhibit 23 was a Shell Oil Company well also, Alamitos No. 39. I have a copy of the record I made at Nesa No. 1 well.

Mr. Mattingly: I offer in evidence the record which has just been identified by the witness as being of the Nesa No. 1 well, as Plaintiffs' Exhibit No. 24, and that Exhibit No. 24 is the same as Exhibit D-8 attached to the Walker depositions.

[Printer's Note: Plaintiffs' Exhibit No. 24 is set out in full in the Book of Exhibits.]

A. The date which was written on that chart is not correct. It was inadvertently put May 7th, when it really was March 7th.

Q. Do you know who put the date marks on the chart you have referred to, on Exhibit 24?

A. I put it on there.

Q. The May 7th date was a mistake that you made?

A. Yes, the two months being similar in spelling, I made the mistake.

Q. Will you explain briefly what is shown on the chart you have just produced, Exhibit No. 24, and mark the various points to which you refer?

A. About three-quarters of an inch from the left-hand end of that chart——

The Court: That is the one that does not have the time chart on it, does it?

A. No, there is no time scale on that. There is a break [189] in the heavy black line, and the thin line extending toward the top, and that is where the

(Testimony of Cranford P. Walker.)

gas was discharged into the well to create the pressure impulse No. 1. The protecting valve on that sheet is not open until we get down about six inches from No. 1, and that point is marked No. 2. I presume that was where it was opened, because it is so quiet until we get to that point. Then going on until we get to within about one inch of the large reflection, near the right-hand end of the chart, there is a small deflection of the light beam toward the bottom of the chart. That would be a rarefaction, marked No. 3. I don't know what that represents. Then the large reflection extending almost to the top of the chart is a fluid level, No. 4.

Mr. Mattingly: Q. Are any of the wavy portions of the line No. 2 in No. 4 reflections from tubing collars?

A. No, there was no tubing in the well when we made the test.

Mr. Babcock: There might have been casing collars, Mr. Walker.

A. There could have been some of them; no doubt are.

The Court: Inside casing collars?

A. There is a space between the sections of the casing. They don't come quite together, and the enlargement of the annular space at that point, those are recorded at times.

Mr. Mattingly: Will you state very briefly what you did subsequent to the test on March 6, 1936?

[190]

(Testimony of Cranford P. Walker.)

A. We made a large number of tests, primarily to check the accuracy of this calibrating equipment for measuring the velocity at which the waves traveled in the well. We did that by finding wells where the liner top was exposed, and at a known location, and making a record from which we determined the velocity at which the wave traveled to the liner top and back, and then set up our calibrating equipment at the well head, and determined what the velocity the shot traveled at, according to the calibrating equipment, and made a comparison of the two. We were trying to find out whether that device for measuring the velocity at which the wave traveled in the well would be commercially successful.

Q. How did the result of your comparison between your charted reflections from tubing catchers and liner tops compare with the timing of velocity indicated by your calibration tube 2?

A. In some cases the results or the check showed that the calibrating tube got excellent results, and in others it was way off. After that, when operators didn't place something in there at a known location to use as a measuring stick in the well from which to determine the pressure wave velocity, we recommended the installation of something on the tubing, the first time the tubing was pulled, to use for calibrating [191] the velocity at which the waves traveled, from which the fluid level could be accurately determined. And in every case where it was possible we made use of the liner top, because

(Testimony of Cranford P. Walker.)

that was usually pretty accurately located. In many cases we had to use the tube catcher as a yardstick, although its location was no infallible.

The Court: In making the calculations you use the speed of sound to determine the rate of travel of the pressure impulse?

A. Where we had a marker in the well, like a liner top, if it took the wave, say, 10% longer to get to the fluid and back than it did to get to the liner top and back, we knew that the fluid level was 10% farther down the hole than the liner. It was just a matter of straight proportions. Sometimes we measure the chart and sometimes we use the time scale to get that ratio.

The Court: But what was your calculation on the time scale? I mean, what did you use, the speed of sound?

A. Yes. As the speed of sound in well gas varies less than 800 to approximately 1470—less than 800 to over 1470 feet per second, it is necessary to get some measure of the velocity of the wave in each particular well.

The Court: That is the medium through which the pressure impulse must travel?

A. Yes, your Honor. And that wave velocity is very seldom uniform from top to bottom. It sometimes increases and it sometimes decreases as it goes toward the bottom of the well, due to [192] special conditions in a particular well.

Immediately following the tests on March 6, 1936, we made subsequent tests. During that period we

(Testimony of Cranford P. Walker.)

made demonstration tests, also measured fluid levels in the wells, and in some cases the operators questioned the accuracy of the equipment. They found that the fluid levels, as reported by us, were higher than the fluid levels that they found. That is, the fluid levels that we reported for the well operating were higher than the fluid levels that they found with the well shut down and determined by running a bailer into the well. So we were pretty much at sea. We didn't know what to do about it. The thing to do was to determine the pressure at the pump instead of the fluid level. We soon found that when the well started up and began making gas the fluid was lightened considerably. In some cases it actually came up the hole when the well was started up and producing, instead of going down. It seemed to be that the fluid level was almost valueless. So I started building up casing pressure, trying to eliminate that fluid, the weight of which wasn't known, and get the final fluid level as close to the pump as possible, and then from the casing-head pressure to determine what the pressure was on the surface. And not knowing any different, we assumed that what fluid was left above the pump was gas free, or practically so, and weighed the same as the oil out in the tank where the gas then escaped. So we used that method for quite a while, displacing all the fluid we could, not knowing what value or weight to give it [193] in determining pressure at the pump. Many companies, and the major companies in particular wanted that, instead

(Testimony of Cranford P. Walker.)

of a fluid level. A fluid level gave them something that told them they were not producing the well at its maximum capacity if the fluid level was any great distance above the pump or above the producing sand. It was some information, but not the kind of information that most of them wanted.

Mr. Mattingly: Q. Then, as I understand, you made some of these tests, and during the making of the tests you built up the casing pressure so as to attempt to push the fluid level down to the entrance of the pump; is that correct?

A. That is correct, yes.

Q. By doing that you then determined what your casing pressure was. What did that tell you with reference to the pressure at the pump inlet?

A. To determine the pressure at the pump inlet we took the casing pressure, and by means of a formula worked out by Mr. Dice of the General Petroleum, I believe, at that time, we found out how much to add to the casing pressure to give us the pressure at the fluid surface.

The Court: That is the weight of the gas?

A. The weight of the gas. Then to that pressure in the fluid surface we added the pressure which the remaining column of fluid then exerted at the pump at that time. The total then, the casing-head pressure plus the pressure exerted by the gas [194] column, plus the pressure exerted by the remaining fluid in the well gave us the pressure at the desired point, which was usually the pump.

(Testimony of Cranford P. Walker.)

The Court: You didn't know what the pressure of the remaining fluid was?

A. No. We assumed that it was gas free, around 40 pounds per inch, because that much pressure would be exerted at the pump, or a little less. That was where the bug came and we didn't know whether to go ahead with it or throw it all into the ocean or what to do, for a while. We went on to displace as much of the fluid as we could, where the operator wanted the pressure at the pump and would not be satisfied with a plain fluid level determination; and kept that up for quite a while. And they knew just exactly how we were arriving at it. We didn't know what the density of that remaining fluid was; neither did they; but it gave them information which was very valuable in many cases. It was very much better than no information at all, or better than straight fluid levels. We found fluid as light as six pounds; that is, it would exert a pressure as low as six pounds per each hundred feet of fluid column; six pounds per square inch; whereas, the average is around 38 pounds per hundred feet of fluid column.

The Court: Well, that is pretty light, isn't it?

A. Yes, that is very light.

The Court: 38 pounds per hundred feet? [195]

A. Water is a little over 43 pounds per hundred feet.

The Court: I see.

A. And this oil will average around 38 pounds per hundred feet of height of fluid column.

(Testimony of Cranford P. Walker.)

Mr. Mattingly: Q. Did you ever attempt to make density determinations about this time?

A. Yes. We call those also density determinations; displacing the fluid, and the ratio between the fluid displacement and the pressure required to displace the fluid, we called it the average fluid density and reported it as such to some of the operators. It was an average fluid density. We didn't know at that time that that fluid density was constant, but we were able to determine the average fluid density, because we may displace it a thousand feet with a certain amount of pressure, and we knew that was the average density of that column, from where we found it at the low pressure to where we found it at the high pressure. We first discovered that density of that fluid column was constant in December of 1936. Somewhat prior to that time we had suspected that it was constant. We made tests in wells where we used to maintain two different pressures, or three or more pressures, and in some cases they came out, by plotting fluid levels against casing pressure, they came out straight lines. And we suspected, although it was very much against our preconceived ideas, we thought that the farther down you went in that fluid column the heavier that fluid [196] became, because it was under so much more pressure and the gas was compressed so much more than it was at the top, that we had definitely made up our minds, when we started off with that conception, that that fluid could not be constant weight all the

(Testimony of Cranford P. Walker.)

way down, but got heavier and heavier as it went down. In some of our literature we actually said it displaced as much of the fluid as possible until the remaining fluid was compact. We later learned that you couldn't compact it; that the fluid density was constant regardless of how far you pushed it down the hole.

Q. How did you come to arrive at the final conclusion or become convinced that the density was constant in that fluid column?

A. That was, I believe, a test which we made for the Standard Oil Company in December at their Mountain View field, which is near Bakersfield, in December, 1936.

Q. Do you remember the name of the well on which that test was made, which finally brought you to that conclusion?

The Court: Well, was that the same well that the Standard Oil man testified to?

A. It was either Abadie or Wilson. I think it was Abadie No. 1. That was the first time we got up enough courage to admit that we had been converted to the constant density idea. We had had these other tests that plotted out a straight line, but we thought they were accidents rather than a fact.

[197]

Mr. Mattingly: Q. Will you state, if you can, when you first used the information as to the pressure obtained by the method which you had worked out for the purpose of determining the production capacity of oil wells?

(Testimony of Cranford P. Walker.)

A. If I remember correctly, that was at Fruitvale on some well we tested for the Western Gulf *Okl* Company. That was, I believe, January, 1937 or December, 1936. It was just a little later than this test on these wells where we tested this Abadie No. 1 for the Standard Oil Company.

Q. Will you state briefly to the Court the circumstances which *let* up to the development of the registration of the tubing collar echoes, as described in patent, 2,156,519?

A. Well, once in a great while we would get what appeared to be tubing collars on our charts, and about that same time, I believe it was along in December, 1936, we suspected that it had something to do with the length of the connection between our instruments and the casinghead of the well. And in the early part of March, 1937 we took to Maricopa—we had an assortment of pipe nipples so that we could vary the length of the connection between the casinghead and our instruments, and I had worked out certain lengths, multiples of the tubing joints that I wanted to try out, and it was on those tests at Maricopa for the Rio Grande Oil Company that we found which length it was that gave us true collars. Some lengths would give something that looked like collars, but they were not true collars. And [198] we found that the length of casing equal to approximately one-third of the tubing joint length gave us true collars. I believe that was March 6th, I think those tests were started, in 1937.

(Testimony of Cranford P. Walker.)

Q. Did you keep a record of any of the charts on which you used your different lengths of nipples for the purpose of bringing out those tube collar echoes?

A. Well, we no doubt have plenty of charts that would show that. I didn't bring any of them in with me, I don't believe.

The Court: That is No. 19 on the drawing of patent 2,156,519, is that right? A. Yes.

The Court: In other words, 19 would be a length of a definite ratio to the length of tubing?

A. Yes. We didn't use that adjustable length until later. We didn't use it very must at that time, because we found that we could predict from a known length of tubing just what length to put in there, so we used an adjustable sleeve. It was the length, your Honor, between the casing head and the diaphragm No. 23. That is, the significant length. It is from the casinghead of the hole to the diaphragm of the recording instrument.

Mr. Mattingly: Q. Do you have any typical charts, which have been made by the use of your instrument with this collar tuning or collar accenting apparatus, which would illustrate the type of chart which you could make as a result of using that [199] apparatus in connection with your recording device?

A. I think I have a short one here that shows the effect of tuning.

Mr. Mattingly: We have here a chart which

(Testimony of Cranford P. Walker.)

reads, "Well No. 109, date tested 12/5/41", which I offer in evidence as Plaintiffs' Exhibit 25.

[Printer's Note: Plaintiffs' Exhibit No. 25 is set out in full in the Book of Exhibits.]

The Witness: I have the original of these charts which I have just produced. Those charts are sensitized paper. The original comes right out of the instrument, and that is what we give to our customers. There is no negative. That is the positive and that is all there is. We use sensitized paper. This same type of paper that is shown here. The record is made directly on the piece of paper that is run through the machine.

Mr. Graham: But is it understood that these are not charts that were furnished to the companies, but a number of charts were taken, and of the number that were taken certain ones were given to the companies. These that you have produced here are the ones that were not given to the companies.

The Court: Taken at the same time and under the same conditions?

The Witness: Taken at the same time and under the same conditions. I think in this particular test there were three charts made like this. There was one of this type, which we didn't consider satisfactory, so we changed the tuning and made two of these; and gave one of them to the customer, and this is [200] the other one.

Mr. Mattingly: Q. Will you refer to Plaintiffs'

(Testimony of Cranford P. Walker.)

Exhibit 25 and explain what is represented by the two charts appearing on that exhibit?

A. That exhibit—the chart at the top has the number 1 on it, and the one at the bottom is No. 3. The top chart, No. 1, was taken with our instruments tuned to the tubing collars. No. 3, the one at the bottom, the length of pipe (18 of the drawing of patent 2,156,519) was changed to tune the instrument to casing joints.

The Court: The one on the bottom of the chart No. 3, those are all rarefaction waves; is that right?

A. Primarily, yes, because the impulse is created by discharging a slug of gas from the well, instead of injecting a slug of gas. The well was under pressure. A little gas was discharged to get the impulse. On our equipment, when the impulses or echoes start toward the bottom of the chart, that is created by a wave of rarefaction. If it starts toward the top it is a pressure wave. Both of these charts of Exhibit 25, the pressure wave was initiated by letting out a slug of gas from the well.

Mr. Mattingly: Q. And the reflection from the casing joints, which are represented here on what is called chart No. 3 of Plaintiffs' Exhibit No. 25, those appear to be recordings initiated by waves of rarefaction. When this wave hits the gap [201] in the casing a wave of rarefaction is reflected back to the casinghead. The tubing collar reflections, which are represented on chart No. 1 of Exhibit 25, those were initiated by waves of compression.

Q. Mr. Walker, when you first started into the

(Testimony of Cranford P. Walker.)

field of finding fluid levels by this apparatus which you have described, what was the reception that was given to you by the commercial oil companies?

A. Well, they all seemed very happy that something had been produced that would enable them to find out what was going on at the bottom of a pumping well without having to remove the pumping equipment from the well.

Q. Did they accept immediately this information, which you were giving to them as to the location of the fluid levels and determination of pressures, as being correct?

A. The greatest step of evolution that we made was when we could show them every collar in the well. Before that there were a lot of doubting Thomases, particularly among those who had not investigated our equipment. The major companies had made a pretty thorough investigation, but there were many small operators who had not made such an investigation, and they were very skeptical in many cases. The man in the field usually wanted to pump his well clear to the bottom and do the job a hundred per cent. At that time everybody was trying to get all the oil he could before his neighbor got it. They are supposed [202] to have quit it now. But at that particular time there was no proration, voluntary or otherwise, and every fellow wanted to get all there was before his neighbor took it. And every production foreman that was found with a well that he wasn't pumping clear down to the bottom, but pulling it out as fast as it ran into

(Testimony of Cranford P. Walker.)

the well, it was a black mark against him. And we found so many of them that were not pumping their wells down that they were inclined to doubt the accuracy of our results. We were striving to find something that would convince them, and when we discovered how to record these tubing collars our trouble seemed to be over in that respect. They were convinced when we showd them charts where they could count their own tubing collars and show just exactly where the fluid level was. That gave them more confidence in this reflection well testing art than any single step, I believe.

Q. Will you state whether or not your method of obtaining fluid level determinations, pressure determinations and production capacity determinations have been accepted by the oil umpires and those responsible for enforcing the proration agreements?

A. Yes. A voluntary proration was established on a large scale here in the middle of 1939. Before that time they had to demonstrate the capacity of the wells by actually producing them, flowing them or pumping them. But the oil company engineers got together and agreed upon a test which would indicate the capacity of the well, without actually having to move in expensive [203] equipment that would pump their wells to full capacity, and those methods consisted of measuring these hole pressures with a pressure recorder run in on the pump, or this reflection method of ours. And both were adopted

(Testimony of Cranford P. Walker.)

as a means for determining the well capacity on which their allowables would be based.

Q. Does that condition still exist in the oil umpires' office in California here?

A. It is a factor, but it isn't the only factor at the present time, since the government has taken over and the wells operate under the supervision of the Petroleum Coordinator. That is given weight, but it isn't the only factor at the present time.

Q. Has your method of determining these fluid levels, pressures, densities and production capacities been accepted in any other part of the country than California?

A. Yes. In Kansas, where proration is enforced by law, our method is accepted as a legal method of determining the well capacities. I was instrumental in having our methods accepted in Kansas. We had no difficulty in getting them accepted back there. As soon as we showed them that we could record tubing collars clear to the bottom of the well they all lined up in favor of this theoretical method of determining potentials.

The Court: Do they use that extensively in California now? [204]

A. It is still used quite a bit, but before the government took it over a potential was the big factor in determining well allowables. But now there are many other factors that are given weight in addition to the well's capacity. It is still acceeptable as one of the factors.

(Testimony of Cranford P. Walker.)

Mr. Mattingly: Q. Did you encounter any objection to your methods when you attempted to introduce them into Kansas?

A. Yes. The Echometer had been back there working before we took our equipment back, and they at that time were not able to record the tubing collars far enough down to determine the fluid levels accurately where the wells were small wells and fluid levels were close to the bottom.

Q. Do you know and did you know at that time who was operating the Echometer?

A. The International Geophysics, Inc., headed by Mr. J. J. Jakosky.

Q. Did you know Mr. Jakosky?

A. I knew of him and had seen him and met him. Yes, I knew him.

Q. When did you first meet Mr. Jakosky?

A. I met him at Huntington Beach on November 7, 1936 when we were making a fluid level test in a well for the Union Oil Company, known as Copeland No. 19. He came to the well while we were making the test in company with Mr. Basil Kantzer, an engineer for the Union Oil Company, and had a camera with him. Mr. Kantzer introduced [205] him to me and told me that he was a man who did research work for the Union Oil Company and he would like to look at our equipment and get all the information, and asked for permission for him to photograph the equipment, which was very unusual, but there was nothing else for

(Testimony of Cranford P. Walker.)

us to do, since the request was made by a company that was giving us a large amount of that work. At that time we could do nothing else but consent to his taking pictures of our equipment.

Q. At the time of that visit of Mr. Jakosky to the well on which you were using your apparatus, was there any other company or competitor in the field of making these fluid level determinations by the use of these sounding methods?

A. None that we knew of.

Q. When did you first learn that there was a competitor in the field?

A. I heard about it, I think it was in June or July of 1937.

The Court: That you first heard of Jakosky's efforts——

A. Yes.

The Court: ——or the Echometer?

A. It is one and the same thing. Someone told us that they had a truck down in Dominguez field trying to do the same thing we were doing. I believe that was some time in July.

Mr. Mattingly: Q. Did I understand you to say, Mr. Walker, that Jakosky, the International Geophysics, and Echometer are all one and the same thing with reference to this Echometer [206] apparatus?

A. They were present, yes, when Echometer was first brought out. After I found there was a competitor in this field, I heard that they were trying to record collars, and trying to determine bottom hole

(Testimony of Cranford P. Walker.)

pressures, just as we were doing, and I was very much disturbed by it, of course, because I felt that there wasn't enough of that type of work for two people in California, so I immediately began preparing patent applications to cover the method that I had managed to develop for testing these wells, and write material for the applications on this method of determining bottom hole pressures, by depressing the fluid, and building up casing pressure; by the method of determining the fluid level; by recording and counting collars; the method of tuning, which I had worked out at Maricopa; also methods of tuning electrically.

The Court: Are you reading?

A. No, all I have is just a bunch of dates, which everybody is welcome to see.

The Court: I have been still thinking about this chart; the pressure waves and rarefaction waves. I understood you to say that you knew, before you applied a carbon microphone, or the other kind of diaphragm microphone, that you would get a rarefaction wave from the perforated casing in the well, or perforated liner, as distinguished from the pressure wave above there.

A. I did not mean to say I knew it, if I did. I said [207] I knew that a carbon microphone would record a pressure wave, or a rarefaction wave.

Q. Did you know that you would get rarefaction waves in wells? That is what I am trying to get at.

A. No, not at that time.

(Testimony of Cranford P. Walker.)

Q. You know that now; but did you know it then?

A. No, but to get a true reproduction of what is reflected from the well it will have to work both ways. Most pressure waves are immediately followed by a rarefaction wave. It is much more perfect to have something that will exactly reproduce something that will come from the well, than to have something that will produce only half of it.

Q. Now, you know that you get rarefaction waves, where you don't get a pressure wave, instead of a rarefaction wave following a pressure wave?

A. A pressure pulse; sometimes there isn't very much of a rarefaction zone following it; by adjusting instruments we can minimize that rarefaction wave that follows the pressure wave, but just a single pressure pulse, there isn't very much rarefaction following it.

Mr. Mattingly: Q. Prior to the time that you selected this equipment, you had some idea of what sort of thing to expect to find in a well; that is, you knew you would find obstacles, such as tubing collars, liner tops, tubing catchers, which would constrict the space; you knew that before you started working, did you? [208]

A. I did not know an awful lot about it, but I wanted to have something which would show exactly what was in there, and it turned out to be very fortunate that I did select the type of re-

(Testimony of Cranford P. Walker.)

corder I did, because I ran into all those complications, as soon as I got started in the field.

The Court: Some emphasis seems to be placed upon the importance of a recorder being part of this method. If that is the case it strikes me it would be important if you could get an instrument that will indicate to you by a diagram the different kinds of waves that you are running into. I am not yet getting what was in my mind, whether or not you knew or expected to find rarefaction waves from the perforated casing.

A. No, that wasn't anticipated at that time. I didn't anticipate it. It was just a fortunate choice of equipment that I made that enabled us to get all those things after we got into service.

The Court: What made you think you would get any rarefaction waves?

A. Because in studying sound, they teach you that any pressure wave is followed by a rarefaction wave. That is, sound which is repeated, vibrations, are bound to be all pressure waves and are followed by an equal wave of rarefaction. The single pressure pulse is a little different, I believe. The rarefaction wave that follows the single pulse is a little different from a rarefaction which follows an oscillation ether or sound wave that repeats.

The Court: Well, was that rarefaction wave coming from [209] the perforated casing, the rarefaction wave following a sound pulse, or the one following a pressure impulse?

(Testimony of Cranford P. Walker.)

A. It didn't have to follow anything. If you had discharged that gas or impulse into the open pipe, say a thousand feet long, when the wave reached the end of the pipe you would get a wave reflected back. A low pressure wave or a rarefaction wave would be reflected back, starting into that piece of pipe. So that when you start those perforations, that is similar to a wave when it emerges from the end of an open pipe.

The Court: Then your rarefaction wave is the same return wave that you get from the surface of the fluid, isn't it?

A. It is similar, except it is a rarefaction wave instead of a pressure wave.

The Court: In other words, you get a rarefaction wave from the surface of the fluid?

A. No. The pressure wave itself is reflected from the fluid. Nothing happens except it bounces back, just as it goes down and hits the fluid. It is a high pressure zone.

The Court: Let me see if I understand you correctly. The reason why you chose the type of microphone that you did choose in making your first equipment for the recordation of the pressure wave and the rarefaction wave, if I understand you correctly, was because on the theory of sound pressure waves are followed by rarefaction waves?

A. That is exactly correct. [210]

The Court: And it wasn't, am I to understand, because you expected to find rarefaction waves by themselves, as you have found?

(Testimony of Cranford P. Walker.)

A. That is correct, as I remember it, your Honor.

Mr. Mattingly: Q. You were testifying that you had assembled the information together necessary to file patent applications. Did you actually file those applications?

A. Yes, on all those which I mentioned yesterday.

Q. And you mentioned, I believe, that you filed an application covering the method and apparatus for finding fluid levels; is that correct?

A. Yes. That was the application which resulted in the patent in suit, 2,156,519.

The Court: Just a minute. Do you claim that you were the first one that discovered that rarefaction waves return from a perforation in oil well casing, rather than pressure waves?

A. Well, that is what you would expect to get, but as far as I know it was the first——

The Court: No. Are you sure you are the one who discovered that?

A. I believe I am the one who made the first record of that fact. Whether it was a discovery or not, I don't know. We didn't claim it as such. And incidental to that, the top of the perforation is frequently used as a target in there by means of which to locate the fluid level. I shouldn't say frequently; [211] occasionally it is used, when we haven't accurate information on the tubing string, the joints and how many there are, we sometimes have used that as a known point which is accurate. The be-

(Testimony of Cranford P. Walker.)

ginning of the perforations is accurately known.

The Court: Yesterday it was stated, in the course of the testimony during the day, by someone, that those spaces in the joints of the casing collars reflected on the recorder. Now, are those pressure waves that return and are reflected on the recorder, or are those rarefaction waves?

A. If you inject a pressure wave into the well, those are waves of rarefaction and come from that open space between the joints.

The Court: So that would be on one side of the line?

A. On one side of the line. A different side of the line from your pressure wave. And we do record those frequently. And one of our exhibits shows a record where we used the casing joints to measure the distance to the fluid in preference to the tubing collars. That is what causes so much trouble in recording tubing collar echoes, with the interference of these casing joints.

The Court: The wave that comes from that spacing, as drawn on the diagram by counsel, is a rarefaction wave?

A. If we start out with a pressure wave that is a rarefaction wave.

The Court: But the thing that comes back from the tubing joints; that is to say, a projection into the annular space, [212] is a pressure wave?

A. That is correct.

The Court: So that a recording of that would give you the tubing joint on one side of the line

(Testimony of Cranford P. Walker.)

and the casing and spaces on the other side of the line; is that right? A. That is correct, yes.

The Court: You didn't know that when you started, though?

A. No. We knew, at least theory would teach us that is just what would happen, but we didn't know that it would happen in an oil well. I didn't know it. Ordinarily those reflections are so very close together that they almost overlap in many cases, so that it is just a saw tooth type of record that you get.

Mr. Mattingly: Q. The ordinary pressure pulse or a shot of gas going down into the well and hitting an obstacle, would normally produce a pressure echo extending in one direction, that would be followed ordinarily with a resultant rarefaction wave extending in the other direction, would it not?

A. That is according to the theory of sound.

Q. And if you had selected a microphone which had this directional characteristic that would show whether it was a pressure wave impinging on the microphone or whether it was a wave of rarefaction impinging on it, you would have produced a true record of the pressure which is received from that echo, would you not?

A. That is what I had in mind. It was purely a research [213] proposition and I wanted to find out the facts, just what happened.

Q. If you had selected a non-directional microphone, you would have had this result, would you not (indicating) where a microphone, in respond-

(Testimony of Cranford P. Walker.)

ing to a pressure wave, would produce a wiggle in the line extending in one direction. Then when a rarefaction wave impinges on the microphone, that is this rarefaction wave which would follow the pressure wave which would impinge on that, you would get a second recording of a wave in the same direction as this first part of the wave; is that right?

A. That is true with a hot wire microphone. That would be true of a non-directional microphone.

Q. Then wouldn't it be true that the reason you selected a directional microphone was so that when you got two humps in here you would be able to tell whether that was really one obstruction or two obstructions?

A. That was possibly a part of the consideration. I didn't want anything that was false. I wanted a true record of the reflections.

The Court: That arrow that he has drawn, pointing to the left, on the top one, you would get that same kind of recordation from the casing space and joint space, wouldn't you, if it immediately followed a tubing collar? You have drawn a worm on the board there. [214]

A. If it immediately follows the tubing collar or casing joint, you would get that same——

Q. The top one would be the tubing collar, wou'dn't it?

Mr. Mattingly: That would appear to be the tubing collar.

(Testimony of Cranford P. Walker.)

The Court: The next one would either be a rarefaction wave naturally following the pressure wave, or it means a casing space, is that correct?

A. Yes, that's possible.

Mr. Babcock: Mr. Mattingly, in order that the record may be clear, may I ask a question: Isn't the difference between the top curve you have drawn and the bottom one the fundamental difference in the record made by the Depthograph and Echometer?

The Witness: Yes, that is, according to my understanding of it. To simplify these things, we call a wave of rarefaction a negative wave, and a pressure wave a positive wave. I believe that is used in the literature also on sound. It is only an arbitrary designation.

Mr. Mattingly: Q. And that wave of rarefaction, or reflection representing rarefaction, would be followed by a wave compression as a result of the creation of the rarefaction wave, would it not?

A. That is my understanding of it.

Q. In that event you would have a record such as I have just drawn, in which the uppermost loop is extending in [215] a negative direction, whereas in the case of an obstruction or constriction, the uppermost loop would extend in a positive direction?

A. That is correct; the direction of the initial movement indicates what a constriction or enlargement is; in other words, whether it is a tubing collar, or a casing joint.

(Testimony of Cranford P. Walker.)

Q. You mean by initial movement, the line is coming down here straight, and it starts off with a straight line, and the direction of the start of that is the thing that tells you whether or not it is a compression wave or a rarefaction wave, is that right? A. Yes.

The Court: In the record of a perforated casing, they would all start from the center of the line, over the line, and go in a negative direction, coming back to the line, and crossing over to the positive side of the line, is that right?

A. In our instruments they sometimes cross over, and sometimes they do not. Partly a bounce, and partly a wave of rarefaction, I presume. Ordinarily that perforated zone is so long that the pressure wave following the rarefaction never shows up.

Q. So it just comes back to the line, and then it goes straight over, goes like counsel has indicated?

A. No, it comes back on the line and goes straight.

Mr. Mattingly: Q. That is a matter of adjustment of your [216] instrument?

A. Yes; damping it so it doesn't overshoot.

The Court: Is that what you mean by tuning?

A. No, that is something different.

Q. Damping is a mechanical adjustment?

A. Yes.

Q. That is some screw, or something like that on it? A. That is correct.

Q. In your mechanical recorder, with the light

(Testimony of Cranford P. Walker.)

and mirror, your needle works back and forth. Is there any bounce of that needle, or does that accurately come back to the line when the wave stops and then goes on straight?

A. Yes, we have a damping adjustment on it, which, when opened up, and the damping is made ineffective, there is a bounce.

Q. Resulting from the weight of it, and the jiggling back and forth?

A. Possibly, whichever it shows, whether that is the weight of the diaphragm or the weight of the gas.

Q. You call it a bounce?

A. That is a good name for it. Unless you call it an overshooting.

Mr. Mattingly: Q. I believe that you stated you gathered together the information and prepared, or had prepared, and filed a patent application of your methods of determining the pressures and densities and production capacities? [217]

A. Yes.

Q. Is that the application which resulted in reissue patent 21,383?

A. It is. The patent application which finally resulted in patent 21,383 was issued as an original patent, having another number, before the reissue was applied for.

Q. And the original patent or application about which you have just testified issued on June 6, 1939, is that correct?

(Testimony of Cranford P. Walker.)

A. It was issued early in 1939. And patent 2,156,519 was issued on May 2, 1939.

Q. What did you do with reference to the competition by the International Geophysics Company immediately subsequent to the issue of those two patents?

A. They were notified of their infringement of those two patents.

Q. Then what happened?

A. There was a little correspondence, I believe, and Mr. Jakosky, who was head of the International Geophysics at that time——

Mr. Graham: Your Honor, this testimony is objected to as to a notice against the International Geophysics Company. They are not a party to this suit.

The Court: There was something in the pleadings here.

Mr. Mattingly: The pleadings show that the defendant purchased the business and equipment of Echometer from the [218] International Geophysics.

Mr. Graham: The question is of notice in this case, your Honor, and the International Geophysics Company is not a party to this case.

Mr. Mattingly: This testimony is not for the purpose of proving notice given to the defendant.

Mr. Graham: Will Counsel state what it is for?

Mr. Mattingly: Yes, it is for the purpose of bringing out the history of the development of this, and also for the purpose of leading up to the

(Testimony of Cranford P. Walker.)

evidence which I have insisted should be heard by this Court in connection with the attack on the validity of Patent 2,209,944.

Mr. Graham: I don't see the materiality of it, whether or not the International Geophysics had notice of infringement. It certainly would not go to the defendant in this case,

The Court: I am going to let the evidence in. Objection overruled.

Mr. Mattingly: Q. I want to know just what occurred insofar as your personal knowledge is concerned, between you and the International Geophysics, subsequent to the giving of a notice to the International Geophysics of infringement of those two patents.

A. I don't recall what happened between me personally and the International Geophysics organization.

Q. Did you have any meetings with Mr. Jakosky?

A. Yes, I had several meetings with him. [219]

Q. What was the purpose of those meetings?

A. To work out some arrangement by which they could continue to operate under a license from us, under the two issued patents that have been mentioned. Those negotiations or meetings took place over a period from about the middle of July, 1939, I believe, until I think it was some time in February, 1940, and Mr. Jakosky got so unreasonable that we just had to terminate the negotiations. He would have had us pay him a royalty

(Testimony of Cranford P. Walker.)

instead of his paying us a royalty, the way he wanted it written, before we got through with it.

We put considerable pressure on the patent office to have them issue some patents, which were being infringed by the International Geophysics. Those patents were 2,156,519, and Re. 21,383. We wanted Mr. Jakosky to know that we had those patents, and he was going ahead using our method, a method that I had developed, indiscriminately, and making commercial use of them every day. At the same time I had applications in covering those methods, and there was considerable expansion of the service contemplated in Kansas early in 1939, and I felt that the quicker that we let him know what the situation was, the less he would have expanded, and the easier it would be to get him to stop his expanding. So we wanted the patents to clear up such matters, to get those patents brought out as soon as possible.

Mr. Mattingly: Mr. Walker, have you been able to find a chart made by the Depthograph Company, using the tuning for [220] tubing collars which you testified about yesterday?

A. Yes, since I testified as to the date when that work was started, I tried to find a chart which was as close to this date as possible.

Q. Exhibit 25, which was introduced yesterday, is a chart which employed this tuning?

The Court: Did any of the charts which you introduced yesterday have the calibration apparatus?

A. Calibration equipment was not used at the

(Testimony of Cranford P. Walker.)

time the charts were made, but it was used during the tests on which most of these charts were made, and I believe while all of them were made. It is not used at all now; that is, which is referred to as 53 to 67 on the drawing of patent 2,156,519. It has not been used since we began tuning to bring out the collars.

Mr. Mattingly: Q. Will you identify the chart you have just produced?

A. This is a chart which was made on a well in El Segundo on April 24, 1937. It shows the effects of the tuning.

Q. Will you describe to the Court how that shows the effect of the tuning, and will you please show that to the Court as you are describing it?

A. It begins with a break in the line which occurred when we discharged the gas into the well. The larger dots represent seconds, and the others are tenths.

The Court: That is about four-tenths of a second? [221]

A. Yes, where the gas was released into the well. Then the chart has a serpentine appearance for about two inches, which occurred after the initial discharge, and also includes the time when the valve protecting the *diagram* was opened. About three-quarters of an inch——

The Court: We will call that No. 1. Now, what were you stating about three-quarters of an inch?

A. .65 seconds, approximately, from the beginning of the chart there is quite a movement of

(Testimony of Cranford P. Walker.)

the light beam, which represents the point where the safety valve ahead of the diaphragm was opened.

The Court: The diaphragm valve?

A. Yes.

The Court: That is No. 2.

The Witness: Then there is a series of oscillations appearing like the teeth on a saw, and each peak represents reflections from a tubing collar.

The Court: Each peak. That means the mark in the direction of the top of this chart?

A. That is correct, your Honor.

The Court: That is what you call a peak?

A. Yes.

The Court: What is this down here at the bottom; is that a peak?

A. That is a swing-back or over-travel as a result of that peak. [222]

The Court: Is that the bounce?

A. It is a bounce.

The Court: Are those bounces or are they rarefactory waves?

A. There is a wave of rarefaction mixed in there. When the wave ran off the tubing collar the wave of rarefaction was reflected, and that is incorporated in that swing. It is a tuning arrangement, so that it irons out or smooths out the record, so that you could distinguish between where the pressure wave began and where the wave of rarefaction began. The distance between pressure waves represents the tubing joints.

(Testimony of Cranford P. Walker.)

The Court: How do you account for this sort of bull neck here in the beginning?

A. That was a surge of the gas from behind the diaphragm back in front of the diaphragm. When it received this pulse here the gas flowed around the by-pass in behind the diaphragm, then surged back, due to its inertia, to the front of the diaphragm and the diaphragm moved in response to that surge.

The Court: I see. That is, the whole diaphragm?

A. Yes.

The Court: And these are just oscillations of the center of the diaphragm?

A. Those are high-frequency oscillations, the diaphragm moving as a whole.

The Court: I see. You have a pencil mark here of some kind. That is eight-tenths of a second?

[223]

A. That represents ten collars from there to this start. That zone is interrupted by operating the valve. We take that space and lay it over here and find out how many collars belong in that space. This pencil mark represents the end of ten joints of tubing.

The Court: So that the first five seconds after the introduction of the sound you don't consider an accurate measurement due to the disturbances of the microphone?

A. In most cases it is not possible to count the collars in that zone. But we can bridge that zone, as we call it, by taking the length of the zone and

(Testimony of Cranford P. Walker.)

then laying it over where the collars will go and counting off the number of collars that would fit into that.

The Court: Where the pressure impulse has steadied down to a rgular gait?

A. That is correct.

Mr. Mattingly: Would you mark one or more of the peaks that represent tubing collars?

The Court: You have got "static" here. What does that mean?

A. That means that the well was not producing at the time the test was made. The point marked "3" on the card is one of the many peaks representing collars on the chart.

The Court: What is this here in the middle of it, 5.8 seconds, where it narrows down? [224]

A. That is probably where there was interference between casing joints and tubing collars, where the casing joints tended to cancel out the tubing collars, or it could be where there was a group of either——

The Court: Mark that "4" in red pencil.

A. It could be a group of joints which are a little longer than the average or possibly a little shorter. And the next deflection—the next major deflection, which is about a little over seven and a half seconds along the chart,—which is numbered 8—are reflections from the fluid surface. I think that describes the significant points on the chart.

Mr. Mattingly: I offer the chart produced and just described by the witness as Plaintiff's Exhibit 26.

(Testimony of Cranford P. Walker.)

[Printer's Note: Plaintiffs' Exhibit No. 26 is set out in full in the Book of Exhibits.]

The Court: You have got marked here "Fluid level 196 jts"—that is joints, I suppose?

A. That is correct.

The Court: ——"4586 feet." That is the calculation you made on that well?

A. Yes. 196 strings times the average joint length, which our customer gave us, gives us that depth.

The Court: Did you arrive at the depth of it by calculating the speed of sound?

A. No, we didn't use the speed of sound. We simply counted the joints.

The Court: Can you do that from this chart?

[225]

A. Yes. They had told us what the average length of these joints was, and we multiplied the number of joints shown on the chart by the average joint length to obtain the depth to the fluid of 4586 feet.

Mr. Mattingly: Q. Mr. Walker, in addition to the activities of the Depthograph Company in measuring fluid levels and giving the other services of pressure determinations, density determinations and well capacity determinations, has your company ever manufactured and sold or leased any Depthograph instruments?

A. Yes. There have been two leased and one sold. One was leased to the Texas Company and

(Testimony of Cranford P. Walker.)

the other one to the Shell Oil Company. The one leased to the Shell Oil Company is the apparatus which was referred to by the witness Gilbert in his testimony here. We are receiving rental and royalty from The Texas Company unit, and royalty from the Shell Company unit.

Q. Mr. Walker, do you have any photographs of the Depthograph apparatus about which you have been testifying here? A. Yes. I found two.

Mr. Mattingly: I would like to offer in evidence the two photographs produced by the witness, as Plaintiffs' Exhibits 27 and 28. The machine is 27 and the man and machine is 28.

[Printer's Note: Plaintiffs' Exhibits Nos. 27 and 28 are set out in full in the Book of Exhibits.]

Q. Mr. Walker, will you refer to Exhibits 27 and 28 and briefly identify the essential portions of the apparatus which is shown? [226]

A. Well, the black object at the extreme left of the photograph is what we call the recorder, it contains the optical system. And hanging onto that recorder in front of it, with the curved surfaces on it, is the camera. And I shall call that "A".

The Court: That is with a lens in front, a round lens. That is the camera?

A. It looks like a lens. It is a dial of a meter.

The Court: All right. "B" is the camera.

A. Well, down at the lower right-hand corner, the cylindrical bright object extending up almost

(Testimony of Cranford P. Walker.)

half way up on the recorder is what we call a receiver. It contains a diaphragm. That will be "C".

The Court: Before you get away from these bright objects on here, is this business with a valve on the top and looks like an oil gun, is that part of "C"?

A. That is a part of "C". That filters the gas which is allowed to pass back of the diaphragm into the space occupied by the mirror and its mechanism. That is shown as 25 on the drawing of 2,156,519. I suppose we should call that "D" on this photograph. Then coming down to the lower left-hand corner of the photograph there is a piece of pipe with a cap on the end of it which we call the impulse chamber, and it is a chamber that we store a little gas in to create the impulse in the well.

The Court: That is 12 on the drawing of 2,156,519? [227]

A. Yes, your Honor. And at the right-hand end of that chamber there is a gadget with quite a number of bolts through it, which is the quick-opening valve for discharging the gas from that impulse chamber. And that is "F" for the quick-opening valve. I believe the only other significant part left is the protecting valve, which is the handle in the background just behind the handle of the quick-opening valve. That is shown as No. 21 on patent 2,156,519. I will mark the valve "G."

Mr. Mattingly: Q. Is the flask referred to by

(Testimony of Cranford P. Walker.)

the number 11 in patent 2,156,519 shown on this photograph, Exhibit 27?

A. No, it isn't. It is normally carried on the truck, but it isn't visible in this photograph.

Q. Is there any part in the photograph which represents the tubing 13 as shown on patent 2,156,519?

A. Yes. There is a hose down in the lower left-hand corner of the photograph, which I will designate as "H".

Q. Will you tell the Court what that part is which the Court referred to as a stereopticon effect?

A. That is just a hood to keep the light from getting into the recorder and fogging the film. There is another part on that which we could identify, since the Court asked a number of questions about it, and that is part 52 on the drawing of 2,156,519, which shows on the photograph, and it is a sensitivity control. There is a damping valve on top of "D". I will mark it "J". "J" belongs about where the character 24 is shown on the [228] drawing of 2,156,519, but it is not shown on the drawing.

The Court: That is an addition, then "J" is an addition?

A. It is a detail that has been used ever since we started, but it wasn't put into the patent drawing.

The Court: Where is the tuning joint?

A. The tuning is not shown on that photograph.

The Court: You didn't tune this well?

(Testimony of Cranford P. Walker.)

A. No. There was probably a liner top exposed or some other marker from which the fluid level could be determined.

The Court: Where does your apparatus begin in an oil well, where the black pipe goes into the white one?

A. That is correct.

The Court: All right. Mark that "L".

Mr. Mattingly: Q. Will you identify the flask shown in photograph Exhibit 28, Mr. Walker?

A. Well, in the truck there is an oil can visible and there are two flasks, one above the other. We call them bottles; gas bottles.

The Court: Is the tuning apparatus here?

A. No, the tuning isn't shown there. It wasn't used.

The Court: Is all this your equipment that shows above the derrick floor?

A. All except the valve. That is, our equipment begins at the valve. [229]

Mr. Mattingly: Q. Will you mark that valve with the letter "N"? I will designate the bottom one of the two with the letter "M".

The Court: Is this an identical piece of equipment as shown in 27?

A. I believe it is.

Cross Examination

By Mr. Graham:

Q. Mr. Walker, referring to these exhibits, 27 and 28, about when and where was this exhibit 27 taken?

(Testimony of Cranford P. Walker.)

A. I think that was in 1939, taken on a Union Pacific well at Wilmington. Exhibit 28, I believe that was the same year. I can find those exact dates, if it is important, but those are just guesses I am making now. These photographs, exhibit 27 and 28, however, illustrate the type of apparatus, in its essential details, that we were using in the latter part of 1939 and 1940, and from then on to the present time.

Q. Mr. Walker, I understood you to testify originally, before you were particularly asked about specific applications, that you filed applications on these different developments that you made; is that correct?

A. I made that statement, that I had filed applications on the developments that I had made.

Q. Have you filed other applications than those that have [230] been specifically referred to in your direct examination?

A. Yes. The ones to which I testified were filed in September and October, I believe of 1937. I think those applications are directed to apparatus or methods which I have testified to on direct examination.

The Court: Tell us how many applications there were.

A. As I remember, there were three filed about the same time.

The Court: Other than these?

A. No, not other than these; including these.

(Testimony of Cranford P. Walker.)

Mr. Graham: Q. Well, there are three of these, Mr. Walker, aren't there?

The Court: Three granted and one abandoned. There are four, aren't there?

A. Well, one is a division of the original application. One, if I remember correctly, covered the method of depressing the fluid by building up pressures or changing the gas pressure in order to determine bottom hole pressures and well potentials. I think that was one application. And then another original application covered the method of counting the collars to determine fluid levels, using liner tops and catchers for the purpose of determining fluid levels, tuning for the purpose of accenting the collars and it also covered some structural features of the instrument. The third one I referred to covered all electrical [231] apparatus, including electrical tuning for the same purpose as accenting the collars.

The Court: Is that one of these?

A. No; but I mentioned it in the direct examination testimony as applications which I prepared material for and applied for at that particular time.

Q. One of these that you refer to is serial number 164,534, filed September 18, 1937, is it not, that is referred to in page 3 of the reissue, column 1, line 73.

The Court: "And in my co-pending application, serial No. 164,534."—is that what you are referring to. A. Yes.

Mr. Graham: Q. I understand, Mr. Walker, that

(Testimony of Cranford P. Walker.)

that is the one that is directed to an electrical system instead of a mechanical system, shown in the patents in suit; is that correct?

A. Such an application was filed, but Mr. Graham, I can't identify it by application numbers, because, unfortunately, I have never familiarized myself with them by numbers.

Q. Will you permit counsel to say?

A. Yes.

Mr. Mattingly: Yes, that is the application.

The Court: That is the application for electrical tuning and recording?

Mr. Mattingly: That is correct, your Honor.

[232]

The Court: And the use of what we call an electrical microphone?

Mr. Mattingly: That is right.

The Court: Rather than mechanical?

Mr. Mattingly: That is right.

The Witness: Such an application was filed in September, 1937.

Mr. Graham: Q. Have you a copy of that, Mr. Walker—I understand that counsel was to have a copy of that in court.

Mr. Mattingly: I have a copy of that in court, that application.

Mr. Graham: Will you kindly produce that application?

Mr. Mattingly: This is the certified file wrapper of that application and contents of the file wrapper, which I ordered immediately after the taking

(Testimony of Cranford P. Walker.)

of the Walker depositions, at Mr. Babcock's request, and it contains all of the application papers up to that time At the time I ordered them there had been entered in that application file the following papers: No. 1 is a request for further explanation of the patent office action of January 14, 1942, and that paper is dated April 6, 1942; an official United States patent letter in response to that request for further explanation, the letter being dated April 11, 1942; an amendment dated April 7, 1942, which was prepared and filed in that application by me; and an examiner's amendment, which is an amendment prepared by the examiner in the Patent Office, dated July 22, 1942; and an official notice of allowance in that application, dated July 2, 1942 —which [233] completes the file wrapper of that application. May these papers be attached to the file wrapper, and the file wrapper, with papers attached, be marked for identification as Plaintiffs' exhibit.

The Clerk: L.

Mr. Mattingly: I might point out that the copies which I have referred to as these additional papers are merely typewritten copies, but my official office file is here.

Mr. Graham: We will take your word for it, Counsel, if you say they are correct copies.

The Court: What is that, 164,534?

Mr. Graham: Yes, filed September 18, 1937.

The Court: Is that still in a pending status?

(Testimony of Cranford P. Walker.)

Mr. Mattingly: The present status of that application is that it has been officially allowed, and is merely awaiting payment of the final government fee to issue as a patent. I do not believe that the final fee has as yet been paid in the case.

Mr. Graham: Q. Mr. Walker, is there any way with your system of distinguishing one restriction in the annular space from another; that is, can you tell whether you have a tubing catcher or liner top that causes a particular reflection?

A. There is a little difference between the refletcions from the tubing catcher and liner top.

Q. Then, is your answer yes?

A. Ordinarily, yes. [234]

Q. Will you please tell how you can distinguish between the two?

A. A tubing catcher, when you run off of the bottom and of the catcher there is a negative wave reflected. Assuming it is a positive from the top end, so that it has a greater tendency for the light beam to be reflected from below to the center line than it does from the catcher, it tends to stay up, and the reflection is recorded from the catcher.

Q. You mean that in one case you get also a rarefaction or negative wave?

A. From the catcher.

Q. That depends on how the catcher happens to be built, is that right?

A. No; the body of the catcher is usually three or four feet long. When the wave hits the top of

(Testimony of Cranford P. Walker.)

it, it reflects a pressure wave, and when it leaves the bottom there is a wave of rarefaction reflected.

Q. If that is true, then what is the difference between the tubing catcher and the fluid level?

A. The same difference there is between a tubing catcher and a liner top, the reflection from the fluid level is similar to that from the liner top.

Q. The fluid extends all the way across and fills the entire space, whereas, the liner top just extends in a little way, a part way restriction, you might say, isn't that right? [235] A. Yes.

Q. You say that they give the same reflection, the top of the liner and the fluid level?

A. They are similar; the characteristics are similar. Frequently you get a much bigger reflection from the liner top than you do from the fluid, depending upon your liner, and how far down inside of the liner it is to the fluid level.

Q. If you don't know where the fluid liner top is, you don't know whether you have the fluid level or liner top, do you?

A. That is correct.

Q. Referring to patent 2,156,519, page 4, second column, beginning with line 43, it states:

"Thus by observing the effects of a series of pressure impulses of different intensity or pressure, the operator may determine which impulse is most desirable to produce the distinctive, recognizable and differentiable peaks *c* and *d*, allowing him to differentiate between echo from the tubing catcher and the echo from the fluid surface."

(Testimony of Cranford P. Walker.)

What does that mean by the "series of pressure impulses of different intensity of pressure"?

A. If you use an impulse which is of insufficient strength you may not get recognizable reflections from either of those objects. If it is too strong and the objects are close together they may actually overlap so that one blots out the other.

Q. Isn't there a time interval between them in the travel of that pressure impulse? [236]

A. Ordinarily there is. Frequently the catcher is set very close to the liner top, and if you don't use the right strength of impulse the two will merge and it will be difficult to tell whether it is one or two.

Q. Well, this says, "to differetniate between the echo from the tubing catcher and the echo from the fluid surface."

A. Well, the tubing catcher is frequently close to the fluid surface. It means exactly what it says, that if you don't use sufficient strength you may not get sufficient amplitude. If you use too much they may merge, may not separate from each other and they may be so distorted that they don't have any particular characteristics by which we could identify them.

Q. Mr. Walker, I am asking you what is meant by this statement where you say you observe the effects of a series of pressure impulses of different intensity or pressure. Does that mean you take a number of the charts before you can find out whether you have got what you want?

(Testimony of Cranford P. Walker.)

A. You don't have to take a picture of them. You can tell by watching a reflection on the ground glass. That beam which oscillates in response to the echoes can be focussed. One part of it is focussed on the ground glass on the top of the instrument; that is 38 in the drawing of patent 2,156,519, and the other part impinges upon the photographic record, and by watching that action of that beam on the ground glass we can determine fairly accurately whether we have the right strength of impulse or not. [237]

Q. Remember, we are talking about tubing catchers and fluid surfaces.

A. Yes.

Q. As I understand your testimony, it is that sometimes you can't distinguish between the two?

A. That is correct.

Q. My reading of that part that I have read from the patent, I understood you could then do something to your apparatus by means of which you could regulate it so you could get a difference between the two. Am I mistaken in that?

A. Are you referring to some previous testimony?

Q. No. I am referring to this part that I read to you from Patent 2,156,519, on page 4.

A. Yes, we can do something to it; that is, use the pressure impulse which gives the best reflections as shown on the ground glass.

Q. Then you mean you change around and final-

(Testimony of Cranford P. Walker.)

ly pick out an impulse which gives you the best results; is that correct? A. Yes.

The Court: Of the quantity of gas released into the annular spaces; is that right?

A. Yes, your Honor.

The Court: In other words, whether it is a little one or a big one? [238]

A. That is correct.

Mr. Graham: Q. Then, Mr. Walker, after you have made this adjustment for selection you do get peaks that are distinguishable from each other; is that correct?

A. That is the object of making the series of shots.

Q. And they are distinguishable from each other in the sense that you can distinguish, then, between the fluid level and the tube catcher by the shape of the wave?

A. Practically everything in the well, except the tubing catcher. The liner tops and the fluid levels give reflections which are the same, but a restriction like a tubing catcher, the reflection from that is not the same, because you have a pressure wave and a rarefaction immediately following one another.

Q. Then your answer to my question is "No"; is that correct?

A. I believe that is correct. It is not always possible to distinguish a tubing catcher reflection from some of the other reflections, but it does possess this characteristic by which we usually are able to identify it.

(Testimony of Cranford P. Walker.)

Q. Then if you select a proper impulse you can tell, from the shape of the wave, whether or not you had a tubing catcher or fluid level, is that correct?

A. Sometimes, yes. We don't do it so much by the shape of the wave, however, as we do by the records furnished by the oil companies.

Q. Then it is outside information? [239]

A. That helps.

Q. I hand you exhibits 19 and 20, which are blueprint records which you testified to. Now, are these made with Wyatt and Lehr apparatus?

A. They were made with the same elements, that is, a microphone, amplifier and a recorder, but not with the type of recorder shown in the Wyatt and Lehr patent; a more sensitive recorder than the type which they show in their patent.

The Court: What does theirs show? I have forgotten.

A. Theirs appears to show a typical, what we call a switchboard type of graphic voltmeter or ammeter that has a pen on it that makes an ink record on a moving strip of paper. In fact, they mention it in the patent as being a pen.

Mr. Graham: Q. Do you claim that this apparatus that you use is any different from the disclosure of the Wyatt and Lehr patent?

A. Well, the difference is, it is much more sensitive, much faster.

The Court: What is, yours?

(Testimony of Cranford P. Walker.)

A. The apparatus with which these two charts Exhibits 19 and 20 were made.

The Court. Yours is more sensitive?

A. This equipment with which these record were made. This is an electric oscillograph, whic has a much higher speed than the type which ap pears to be shown in the patent. [240]

Mr. Graham: Q. This difference that you hav pointed out is merely in the recording, the actua recording part of the apparatus; isn't that right

A. That is correct.

Q. In other words, it has an impulse chambe the same as Wyatt and Lehr, a microphone, an am plifier and a recorder? A. Yes.

Q. You do not mean to state or to imply tha with a carbon microphone, an oscillograph with camera recorder, such as you used to make thes graphs, Exhibits 19 and 20, it is not suitable t make a depth record on which tubing collars ap pear, do you?

A. I wasn't able to make it function that wa

Q. Then you cannot say that if that apparatu that you used for making Exhibits 19 and 20, wa properly operated, that it would not show tubin collars?

A. No, it would not.

Q. What is that?

A. I don't think it would.

Q. For what reason?

A. Well, I wasn't able to make it work tha way.

(Testimony of Cranford P. Walker.)

Q. You must know, Mr. Walker, why it didn't work so that you could get these reflections from the tubing collars.

A. Yes, for the reason that there are so many other oscillations that interferred with the tubing collars. For [241] one thing, we found that the length of well connection would completely obliterate tubing collar reflections in our subsequent experiments.

Q. Those oscillations are in there no matter what you use, aren't they?

A. Yes, there are some oscillations bound to occur in that pipe.

Q. Then it is merely a matter of adjusting the apparatus to make it work better?

A. No, I wouldn't say that entirely. You would have to have suitable equipment.

Q. Then is it your statement, Mr. Walker, that Wyatt and Lehr apparatus, properly constructed and operated, will not show the tubing collar reflections?

A. There would be a lot more required than what they show. You have interferences between casing joint reflections and tubing collar reflections, as shown by one of these exhibits you have here. The tubing joint reflections are more prominent than the casing joints, and in many cases you have reverberations in the connection between the instrument and the well, intermingling with those reflections from the casing joints and tubing collars, so that it would not necessarily be able to record

(Testimony of Cranford P. Walker.)

tubing collar reflections. I wasn't able to record them, and that was probably the reason; those three that I have mentioned. [242]

Q. You mean it did record them, but you could not distinguish them, or it didn't record them?

A. Well, they were so intermingled with all the other oscillations and echoes that they didn't come to the surface as separate echoes themselves.

Q. Do I understand that the plaintiffs in this case pay a royalty to Wyatt and Lehr under their patent? A. Yes.

Mr. Mattingly: If your Honor please, during the intermission the defendants wanted to use the blackboard here and suggested that I copy the material which appeared on it as illustrative of the witness' testimony this morning, and I would like to offer that in evidence as Plaintiff's Exhibit 29.

The Court: It may be admitted.

[Printer's Note: Plaintiffs' Exhibit No. 29 is set out in full in the Book of Exhibits.]

Mr. Mattingly: The Plaintiff rests, your Honor. [243]

Mr. Graham: I believe there is an offer before the Court of the Lehr deposition.

Mr. Mattingly: You are offering the deposition of Lehr only?

Mr. Graham: Yes.

The Court: Admitted.

Mr. Graham: Now, may I ask counsel if you have any objection to the Wyatt deposition?

Mr. Mattingly: I will make no objection to the introduction of the Wyatt deposition.

Mr. Graham: Then we will offer it in evidence.

The Court: It may be admitted.

Mr. Mattingly: May I have the exhibit numbers on those?

The Clerk: "M" and "N"; "L" already having been used. That will be "M" on the Wyatt and "N" on the Lehr, as they appear in this deposition.

Mr. Graham: Your Honor, there has been offered a book which has been marked for identification "K". This book contains the prior publications, and while those prior publications at the time the whole book was marked were mentioned, I would like to offer them separately in evidence, as they will be referred to by a witness; and I would like him to refer to them not only by name, but by exhibit number.

The Court: That is, separate exhibits?

Mr. Mattingly: I make no objection to the entry of these as being copies. [244]

The following publications were then offered and admitted in evidence.

Exhibit K-1—Article by Wilde and Moore, published June 30, 1931.

Exhibit K-2—Article by Stanley Gill, published April 4, 1932.

Exhibit K-3—Article by Hawthorn, published in 1933 in the transactions of the A. I. M. E.

Exhibit K-4—Article by Major W. S. Tucker,

HAROLD T. WYATT

a witness for defendant, testified as follows by deposition:

I live at 515 North Reeder Street, San Dimas, California. I am the Production Manager of the Shell Oil Company. I work for the Shell Oil Company here in Los Angeles. I have been subpoenaed to testify.

By Mr. Babcock:

Q. I show you what purports to be a printed copy of United States Letters Patent to Paul E. Lehr and Harold T. Wyatt, No. 2,047,978, granted July 21, 1936, on an application filed November 1st, 1933, for "Method and Apparatus for Measuring Well Depths", and ask you if you are the Harold T. Wyatt who was one of the patentees of this patent?

A. I am. Paul E. Lehr, referred to there, is the gentleman sitting in the room. I know Mr. Cranford P. Walker. He is present here in the room.

Q. Have any rights under the Lehr patent, that I just referred to, ever been given to Mr. Walker or any one associated with him?

A. The Depthograph Company have been licensed to operate under the Lehr and Wyatt patent. It is my understanding that the Depthograph Company is one of the plaintiffs here in suit and that it is a co-partnership between Mr. Walker and others.

Q. What kind of a license arrangement do you have with the Depthograph Company?

(Testimony of Harold T. Wyatt.)

A. I don't know; I can't answer that. I am in general [248] familiar with the terms of this contract.

Q. Do you receive any royalty at the present time from the Depthograph Company?

A. I do.

Q. Do you know about when you first entered into some kind of a contract, either oral or written, with the Depthograph Company or with Mr. Walker?

A. I don't remember just when it was. It was several years ago.

Q. It was after the issuance of the Lehr and Wyatt patent?

A. I don't remember.

I recall something about the history of the development of this invention of the Wyatt and Lehr patent. Lehr and myself were interested in studying well performance; we were interested in gathering data having to do with well performance. I was employed by Shell Oil Company, and Lehr was, too. We were interested in learning how to control and to improve the ability of a well to produce. And this method of locating fluid levels seemed to us to offer a useful means for understanding what was happening in oil wells. So we proceeded to develop our idea that fluid levels could be located from the ground level by the method outlined in the patent which you have quoted earlier.

I do not recall that this development started some time prior to the time we applied for a patent in

published in the Journal of the Royal Society of Arts, dated Friday, January 5, 1923.

Exhibit K-5—Article by Harold K. Ihrig, published in Oil and Gas Journal of October 17, 1935.

Exhibit K-6—Article by Christie, read at the Houston Meeting, October, 1931, entitled "Reservoir Pressures in the Hobbs Field, New Mexico."

Exhibit K-7—Article by Dale Nix, in the transactions of the A. I. M. E. of 1932, entitled "Determination and Application of Depth Pressures in the Yates Field."

Exhibit K-8—Article by Charles V. Millikan on "Bottom-hole Pressures in Oil Wells," published in 1931 in the A. I. M. E.

Exhibit K-9—Article by William Victor Vietti on "Density of Oil-Gas Columns from Oil Data" published in 1931 by the A. I. M. E.

[Printer's Note: Defendant's Exhibits K-1, K-2, K-3, K-4, K-5, K-8 and K-9 are set out in the Book of Exhibits.] [245]

The following prior patents were then offered and admitted in evidence:

O-1—Original patent of C. P. Walker, No. 2,161,733 granted June 6, 1939, of which the patent in suit Re. 21,383 is a reissue.

O-2—Patent of Batcheller, No. 602,422, granted April 19, 1898.

O-3—Patent of Fessenden, No. 1,217,585, granted February 27, 1917.

O-4—Patent of Fessenden, No. 1,240,328, granted September 18, 1917.

O-5—Patent of Tucker, No. 1,351,356, granted August 31, 1920.

O-6—Patent of Behm, No. 1,649,378, granted November 15, 1927.

O-7—Patent of Williams, No. 1,671,262, granted May 29, 1928.

O-8—Patent of Dorsey, No. 1,730,411, granted October 8, 1929.

O-9—Patent of Taylor, No. 1,847,636, granted March 1, 1932.

O-10—Patent of Smith, No. 2,008,934, granted July 23, 1935.

O-11—Patent of Gilmore, No. 2,021,774, granted November 19, 1935.

18—Patent of Lehr, et al, No. 2,047,974, [246] granted July 21, 1936.

O-12—Patent of Kunze, No. 2,116,523, granted May 10, 1938.

O-13—Patent of Scott, No. 2,173,426, granted September 19, 1939.

O-14—Patent of Halliburton, No. 2,201,311, grant May 21, 1940.

O-15—Photostatic copy of British patent to Tucker, No. 138,638, published March 4, 1920.

O-16—Photostatic copy of British patent to Tucker, No. 195,199, published March 29, 1923.

[Printer's Note: Defendant's Exhibits O-2, O-4, O-5, O-7, O-9, O-13 and O-14 are set out in the Book of Exhibits.] [247]

(Testimony of Harold T. Wyatt.)

1933. I can't [249] recall the time relationship between when we thought of it and when we applied for the patent. At about the time we applied for patent, we did experimentation in the field. We built and operated a tool like this of the patent.

Q. I will leave the patent here before you, so that you can refer to it. On page 1 of the patent 2,047,974, in the first column, starting at line 10, it says: "It has been attempted to measure the depth of wells by using a sound wave method in accordance with which a sound is made at the mouth of the well and then the elapsed time is measured for this sound to pass to the bottom of the well and be reflected back", and so on. Do you know whether that statement is true, that prior to the filing date of your application on November 1st, 1933, such attempts had been made to measure the depth of wells by the use of sound waves?

A. It is my recollection that attempts had been made by others.

Q. None had been made by you or Mr. Lehr?

A. I had made none.

Q. You don't know whether Mr. Lehr had or not? A. No.

Q. Were they by the Shell Oil Company, or what knowledge do you have as to these prior attempts?

A. My recollection is that the Shell Oil Company made no such attempt. My recollection is, and understanding at the time, [250] that the attempt was made by the Union Oil Company.

(Testimony of Harold T. Wyatt.)

Q. Whom, of the Union Oil Company, do you know?

A. I do not know.

Q. Just some rumor that you had heard of, or something like that? A. Yes.

Q. In this same paragraph of the patent it says that: "The sound wave method operates more perfectly in theory than in practice," and then gives some reasons for that statement. Is there any basis for that statement in the patent, as far as you know? A. I do not know.

Q. It says further: "In using the sound method referred to, perhaps the crookedness of the well hole has considerable to do with the dissipation of the energy of the sound, causing considerable reflection and partial absorption of the sound waves as they pass down the well and return." Was that statement just put in the patent for camouflage, or what was that put in there for?

A. The answer is, I don't remember why it was put in.

Q. You have no knowledge now as to whether that is so or not, that in using a sound wave method the crookedness of the hole has considerable to do with the dissipation of the energy, and so on?

A. No, I have no knowledge as to whether that is so. As [251] a matter of fact, I have had so little experience with the application that my recollection even as to what knowledge I had at the time is very vague. I am quite sure that I thought the

(Testimony of Harold T. Wyatt.)

whole—all the material contained in the patent, in the application, was true.

Q. What is your understanding of this statement in the patent, on page 1, column 2, beginning line 29, that: "Before proceeding to a detail description of this invention, it should be stated that it employs the impulse wave principle, and the impulse wave is not generated by sound, but is generated by causing a sudden change in pressure at the well head. This change in pressure may be occasioned by a sudden liberation of a sufficient quantity of gas at the well mouth to cause a sudden substantial increase of pressure or a sudden decrease"——

I understand that as it is written; I don't know how to, off-hand, paraphrase it or restate it.

Q. Well, you understand that statement that I just read to you, it means something to you?

A. Yes.

Q. Please explain what you understand to be the distinction between an impulse wave, or a pressure impulse wave, as distinguished from a sound wave?

A. I don't know whether I can distinguish between those two, I am afraid I can't. It has been a good many years since I gave that any thought or did any work on it. I would be very reluctant—in fact, I find it impossible to discuss the two.

[252]

Q. You mean to distinguish between the two, a pressure impulse wave and a sound wave?

A. I can't describe them, I am not able to.

(Testimony of Harold T. Wyatt.)

Q. Well, then this portion that I have just read doesn't mean anything to you, does it?

A. Yes, it means something to me.

Q. Well, it says that the impulse wave is not generated by sound; does that mean anything to you?

A. Yes; that means to me that the impulse wave is not generated by sound.

Q. Well, then, there must be some difference between an impulse wave and a sound wave, mustn't there?

A. The first thing I was trying to explain to you was that I couldn't explain the difference.

Q. Well, there is a difference, but you can't explain it; is that the idea?

A. That is the idea.

Q. On page 1 of the patent, in the first column, will you please read the paragraph beginning line 28 and ending in line 42, I guess it is?

A. (Witness peruses.)

Q. Does this paragraph refer to what you called, in one of your previous answers, well performance? A. Yes.

Q. And which I understand means the ability of the well [253] to produce oil?

A. Yes; oil, gas and water.

Q. The paragraph that you just read refers to pumping wells. What you were interested in at that time, was the performance of pumping wells?

A. Yes.

(Testimony of Harold T. Wyatt.)

Q. Will you explain how you intended to use this data, that you had obtained by the method and apparatus of this Lehr and Wyatt patent, in determining well performance or the ability of a pumping well to produce?

A. We wished to learn the relative position of the fluid level in the annular space between the tubing and casing, the position of the fluid level relative to the pump which was set in the well.

A. That is what we had in mind, in connection with the determination of fluid levels on pumping wells.

Q. Was it your intention to make these fluid level determinations while the pump was operating at different pumping levels?

A. I can't remember.

I am an experienced oil man. I have been in the employ of the Shell Oil Company for approximately seventeen years, and during that time have been engaged in oil field work, mostly production problems. I try to maintain a staff who keep up with the best methods of estimating the potential production of [254] a well, and things of that sort. I haven't done that myself for some years.

Q. At the time you and Mr. Lehr made this invention, you were particularly interested in using this tool as a means of helping you estimate the potential production of wells; is that correct?

A. No, I don't think that is correct; I can't remember that we did that. I can remember we were interested in producing wells to capacity—I

(Testimony of Harold T. Wyatt.)

should not say "we"—I can remember that I was interested in producing wells to capacity, and that I was interested in knowing whether wells were pumped off; in other words, I was interest in knowing when a well was pumping water, the liquid level had been pumped down to the inlet of the pump.

Q. You were familiar at that time with the use of what are called pressure bombs or pressure-recording devices for estimating bottom hole pressures in a pumping well?

A. No, sir, I was not familiar with them at that time.

Q. Then what does this mean here in the patent—I am quoting from the same paragraph I asked you to refer to and read—(reading) "The present method and apparatus affords means for determining well depths without the use of a sand line,". How was the well depth determined with a sand line? A. We used bailers.

Q. To determine what?

A. I used bailers to determine well depths and well [255] pressures.

Q. How could you determine a well pressure with a bailer?

A. I used a bailer which was in the form of a bomb which took a sample of the material in the well under the pressure which existed in the well, brought it to the surface, and observed the pressure.

Q. Well, then, you were familiar with means to determine well pressures, bottom hole pressures, by the use of a pressure bomb, were you not, at the time you filed this application?

(Testimony of Harold T. Wyatt.)

A. I think that we ought to have an understanding of the pressure bombs, perhaps that——

Q. Let me take that out of the question; let's put it this way: There were known ways of determining bottom hole pressure on November 1st, 1933?

A. Yes.

Q. And there were known ways and known methods and apparatus for determining well depths by the use of sound methods, were there not?

A. I don't know whether I understand the question.

Q. Well, I was paraphrasing the patent. By "sound method" apparently in this patent it refers to sound wave methods, where a sound is made at the mouth of the well, and then the elapsed time is measured for this sound wave to pass to the bottom of the well and be reflected to the mouth. [256]

A. My recollection is that I understood at the time that the sound method, as shown in quotations in this patent, could be used for the purpose of measuring well depths.

Q. You understood that the sound method that we have been talking about could be used to measure the surface of the liquid in a well between the tubing and the casing, did you not?

A. I understood that the method could be used, but that the results were unreliable, and I won't state the answer that way, because I don't think we should misunderstand, I wouldn't want my answer to be understood as meaning, or causing some one

(Testimony of Harold T. Wyatt.)

to think, that when I said a method could be used, that I implied it could be used successfully.

Q. Yes. And your answer would be the same as to the use of a sound method to get information in connection with pumping wells; is that correct?

A. That is correct.

Q. And that is, as I understand your testimony, that it had been tried and the results found not very reliable; is that correct?

A. That is what I understood.

Q. And you contemplated, when you filed your application for patent, to use your apparatus and method, as described in this patent, for getting the information in connection with pumping wells—the information I had reference to is—again I [257] am referring to the first column of page 1 of the patent, where at about line 36 it says, "it is also frequently necessary to have this information in connection with pumping wells".

A. We contemplated using this information in connection with the operation of pumping wells.

Q. And by "this information" you mean the information as to fluid levels obtained by operating the method and apparatus of this patent in the annular space between the tubing and the casing?

A. Yes.

Q. Did you intend to use the method and apparatus of this patent to determine the fluid level in the annular space between the tubing and casing, in connection with the procedure to determine or

(Testimony of Harold T. Wyatt.)

estimate bottom hole pressure, or pressure at the pump in the well?

A. I don't remember my intentions.

Q. I will adopt counsel's suggestion, and ask what you ever did with this method and apparatus, —I wish you would tell us what you did in the field with this method and apparatus, and first tell me, if you will, what you built; describe the apparatus that you actually built. Let's take it historically if you can recall, what is the first thing you ever built that would have anything to do with determining fluid levels in wells by the use of either sound or pressure impulses? [258]

A. My recollection is that we built a reservoir for gas under pressure; that we connected that to an impulse chamber; we connected the impulse chamber to the well-head through a quick-opening valve. We opened the valve and created an impulse into the well casing, and we observed the time required for that impulse to travel through the fluid level, or some obstruction in the well, and return to the surface.

Q. That would be exactly in accordance with Fig. 1 of your patent, as near as I can judge; is that correct? A. I think so.

Q. You had a little outlet at the mouth of the well, and it would determine the time it took for the impulse to travel down to something in the well and come back to that outlet, the time being measured from the opening of the quick-opening valve

(Testimony of Harold T. Wyatt.)

to the time a puff was felt at the outlet; is that correct? A. Yes, that is my recollection.

Q. Then did you ever proceed to build an apparatus like Fig. 2 of the patent, where a recorder was used? A. No.

Q. Never used a recorder of any kind?

A. I don't remember using one.

Q. Did you ever use any microphone of any kind?

A. Yes, I remember working with a microphone.

Q. What kind of a microphone?

A. I can't tell you. [259]

Q. Do you know anything about the radio art or sound-recording art? A. No, sir.

Q. In the patent here, on the drawing, Fig. 2, it says, "Microphone", and "Amplifier", and "Recorder". That was intended to be—as far as your understanding at that time, you contemplated just using whatever sound-recording that an engineer might specify there to record this puff; is that correct?

A. As I recollect, our purpose at the time was to provide a means for recognizing return of the impulse wave, a more sensitive means than the human ear and the human hand, and the timing mechanism we had, such as a stop-watch would permit.

Q. And you intended to use more or less just whatever conventional apparatus was available for that purpose?

A. No, I don't remember that. I remember that impulses were difficult to check, and we had in mind

(Testimony of Harold T. Wyatt.)

an arrangement that would amplify the impulses so that they could be more rapidly observed and recorded.

Q. Well, was it any part of your invention, this recording feature; that is, was it any invention on your part, or Mr. Lehr's part, in taking this impulse and writing it down on paper; was there any invention in that part of the system shown here?

[260]

Mr. Mattingly: Wait a moment; I object to that question, asking this witness what is or what is not an invention, and submit that the witness has not been qualified to do such—as a matter of fact, the Supreme Court has not yet determined that they are qualified to make such statement. If counsel wishes to ask the witness whether he considered it was an invention at that time, I have no objection to that.

Q. Consider the question in that light. Did you consider it any invention at that time to use what you have shown here in Fig. 2 of the patent to record the return of this impulse wave?

A. Well, I considered that we had invented the things which were set forth in this patent, and if this is set forth in the patent, then I am sure that I considered that I had invented it.

Q. Was Mr. Lehr a sound-recording expert or familiar with sound recording or the radio art or anything of that sort?

A. I don't know whether he was an expert or not. My frank opinion is, as one who is no judge, that he was not an expert.

(Testimony of Harold T. Wyatt.)

Q. You said that you never built any of this recording apparatus of Fig. 2. Did Mr. Lehr ever build any, to your knowledge?

A. Not to my knowledge

Q. Did anybody ever build any?

A. Not to my knowledge. [261]

Q. Mr. Walker, or anybody else?

A. I didn't know Mr. Walker at that time.

Mr. Mattingly: Is it understood that the previous two or three questions were directed to the time period immediately preceding the filing of the application, or immediately after the filing of the application?

Mr. Babcock: Well, I am talking about any time,—but of course it is limited to what this witness knows.

Q. You never heard of anybody building this apparatus of Fig. 2 of your patent?

A. I find it very difficult to answer that, because I know apparatus has been built—recording apparatus——

Q. And used in a system like that shown in Fig. 2 of your patent? A. I don't know.

Q. Have you got any records of actual work you did in the field?

A. No, I haven't any such records.

Q. Does Shell have any interest in this Lehr and Wyatt patent at the present time? A. Yes.

Q. And does Shell receive any royalty from Walker on this Lehr and Wyatt patent, or from the Depthograph Company?

(Testimony of Harold T. Wyatt.)

A. I don't know. [262]

Q. Is that covered by the contract between yourself and the Depthograph Company? A. Yes.

Q. Did you succeed in determining fluid levels—your experiments, or whatever they were, were they successful?

A. I don't know. Well, let me try to restate the question a little bit in my answer. Our impulses returned to the surface. I don't know what they went to or where they came from, but they came back from it. We sent them like the arrow shot into the air. I don't know where they went, but they came back.

Q. Did you use that information for any purpose at all? A. Yes.

Q. What did you use it for?

A. We used that information to give us ideas as to whether wells were producing to capacity. This was for Shell.

Q. I gather it wasn't done so much for an experimentation, to see whether this would work, as it was to try to determine fluid levels; is that correct?

A. We were trying to determine fluid levels, and we experimented in our effort to determine those fluid levels.

Q. Did you ever try it more than just this one time? A. Would you amplify the question?

Q. Well, how much did you use that system; did you just use it on one well, one time, or did you use it again?

(Testimony of Harold T. Wyatt.)

A. No, we used it—it was used on several wells.

[263]

Q. Well, you wouldn't run it for the second time if you didn't think you found out something of value on the first job, would you; in other words, this wasn't just something you tried and you got nothing of value, and you abandoned the idea—that wasn't it? A. No, the idea was not abandoned.

Q. It was a good tool, only you weren't so sure of your results; is that correct?

A. That is correct.

Q. Did you check with any fluid level determinations by other methods?

A. I can't remember definitely, but I have a hazy recollection that we checked it in wells where we were able to measure the fluid level also with a bomb.

Q. In that case there would not have been any tubing in the well? A. Yes.

Q. And do you recall how it checked out?

A. No, I don't.

Q. Would you explain further what you used these fluid level determinations for, how you applied them?

A. I recall we did this work—when we did this work on pumping wells, if we judged that the fluid level was above the pump, we then made changes in the pumping apparatus to attempt to lower the fluid level in the well. [264]

Q. You had a well with a pump in the tubing; is that correct? A. That is correct.

Q. You had a fluid level in the annular space

(Testimony of Harold T. Wyatt.)

between the tubing and the casing, that fluid level being somewhere above the pump?

A. Correct.

Q. And you determined where that fluid level was, to the best of your ability, by this impulse pressure wave method? A. That is correct.

Q. And then, of course, you knew then the distance from the fluid level to the pump?

A. Correct.

Q. And that was all you wanted to find out, was it, just that distance between the fluid level and the pump?

A. That was all we were able to find out.

Q. You didn't ever operate the pump at different rates, then, and see what happened to your fluid level?

A. I can't remember whether we did that or not. I can remember that we made changes in pump setting, changes in pump operation——

Q. Pumping rate, in other words, or rate of pumping. You don't recall whether you changed the rate of pumping to see what the fluid level would be?

A. By pumping operations I mean changing the arrangement [265] of the valves, or the length of the stroke, or something of that sort. We did those thing in an effort to improve the production from the well.

Q. Well, you did do those things, you did change the operating characteristics of the pump, did you, in response to these fluid level determinations that you made?

(Testimony of Harold T. Wyatt.)

A. When we discovered that the pump was not producing from the well all the liquid which it was apparently capable of producing, we then made changes in the pump.

Q. And you determined that by seeing what the fluid level was?

A. Yes. We judged that when the well wasn't pumped off that it was capable of producing more liquid.

Q. And then didn't you increase the production as response to those determinations?

A. Well sometimes we did, and sometimes we failed.

Q. Well, at least you tried to; you changed the pumping rate, the barrels per day.

A. Well, we always attempted to increase the pumping rate, the productivity of the well, the production of the liquid from the well.

Q. Well, then, you did change the barrels per day, then, or tried to? A. We tried to. [266]

Q. And then did you take any further fluid level determinations or measurements after you tried to change the production rate? A. I think so.

Q. What field were these wells in?

A. As I recall, we did our work in the Los Angeles Basin. There were several fields and, as I recall, we worked in several fields. I recall Signal Hill and Dominguez Hill. There may have been others. [267]

PAUL E. LEHR

a witness for the defendant, testified as follows by deposition:

Direct Examination

I live at 219 Monte Vista Drive, Bakersfield, California. My occupation is division superintendent of the San Joaquin Division of the Shell Oil Company, Incorporated. I am one of the patentees of United States Patent 2,047,974.

By Mr. Babcock: Q. In general do you agree with the testimony Wyatt gave about this patent this morning? A. I do.

Q. Do you have any knowledge as to whether the Shell Oil Company is receiving any royalty from Depthograph, either directly or indirectly, on this Lehr and Wyatt patent?

A. In this patent release which we secured from the company, we were given the patent to deal with outsiders, with the proviso that the Shell Oil Company would be able to use the instrument royalty-free. That is all the right they retained. In other words, there is another stipulation in there, that I am a little hazy on, that they call shop rights, which they have no intention of exercising.

Q. Your testimony, I understand, would be the same as Mr. Wyatt's with regard to the apparatus that you actually built back there some time ago and used to make fluid level measurements in wells?

A. Yes, substantially, it would be very close to the same [268] thing.

Q. You do not know of any records of anything that was done then?

(Testimony of Paul E. Lehr.)

A. There is only one record that was ever made, to my knowledge, and that is, we wrote to the company before ever a patent was filed, outlining our method of testing. In other words, we built this apparatus and we made just a few tests in the field with it, and we wrote it up in the form of a memorandum and sent it to the company, after we had built it. That report was written to Mr. Bagby, and he then transmitted it to Los Angeles. He was superintendent at Long Beach at that time.

Q. In this early work you did, you did connect the apparatus up to the annular space between the tubing and the casing, did you not?

A. Yes, we did.

Q. What kind of tubing did you use in the hole?

A. Some of it was upset and some of it was plain; most of it was two and a half inch, some of it was two; all of it had collars. The average length of that pipe was twenty-two feet.

Q. You have no knowledge of these supposed earlier attempts to measure the depth of wells by using sound wave methods, do you?

A. Only by rumor; nothing definite.

Q. Your testimony is just the same as Mr. Wyatt's in that connection? [269]

A. Very similar to it. As a matter of fact, I didn't hear of that myself until some time after we had made a successful test of our own. Now, Mr. Wyatt might have known of it previously, but I did not.

(Testimony of Paul E. Lehr.)

Q. Do you recall any of the circumstances about these rumors, who told you or where it was supposed to have been carried on, or by whom?

A. No, sir, I do not. I know where I first heard it, but I don't know who told me. It was in the Shell Company office, engineering office, at Long Beach, and the rumor was transmitted to me—I know I heard it from another Shell employee, but just who it was has slipped my mind. As best I can recall, I understood that the Union Oil Company had tried using two sirens, of different pitch, so that they would both run at a certain speed and beat, and from that beat they attempted to get a reflection of it, from allowing it to be put down into the well casing.

Q. You never heard of anybody shooting a gun to get the sound wave?

A. No, sir, I never knew of that until after we had made the patent application. As a matter of fact, I thought that we had invented it ourselves, because I tried the cartridge as well.

Q. In this early——

A. Yes, sir, before I had any knowledge of what had been [270] done by Mr. Batcheller. I tried this cartridge in lieu of my impulse chamber.

Q. And how did that work out?

A. To the best of my recollection, all I think I used was a 38 cartridge, fired directly into the annular space. This happened not to be an oil well at the time, because I was very afraid of it, I ran it in

(Testimony of Paul E. Lehr.)

a hole that had mud put in the lower part of it, and I knew it was gas-free.

Q. This was just a blank? A. A blank 38.

Q. Fired with a revolver?

A. No, sir. I don't know whether you are familiar with it or not, but these alemite guns, when they get stuck—they are used with a cartridge attachment—if you take and hit these things to unplug them—that is what I used, I put it right inside, as near as I could get it inside, and tried that. I didn't use any nipple, I just held it. I didn't connect it to the casing.

Q. Drilled a hole in the casing?

A. No; everything was open. Through the inlet side and the outlet side, you see, the two openings on the casing-head, it was covered over the top, I went in on one side and fired the cartridge, and there was no attempt at packing made; in other words, you know, it is almost like you had exploded it right over the top of a well head. [271]

Q. There was tubing in this well, though?

A. No, sir, not in that particular well.

Q. You only tried that once?

A. No, no, I tried it in another well, later on, that did have tubing in. Also it was mudded in the bottom, so it had no gas. And at both times the type of impulse I got—I got a return in the first well; the second well was deeper, and I got a very slight one, as a matter of fact, compared with the impulse chamber, three pounds pressure, you know,

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when I released it here—gave much more of a return than a 38 cartridge.

Q. Well, I gather that you agree with these statements in the patent that in using a sound method the results are not satisfactory?

A. That was the basis for my statement.

Q. You said that was the basis for your statement; you mean the statement in the patent is based on your knowledge at the time?

A. That is correct.

Q. The statement I am referring to is on page 19 of the file history of the Lehr and Wyatt patent, particularly where it says, referring to Batcheller: "* * *it was not found satisfactory for the reason that there is not enough energy in the sound waves produced,". Did Lyon and Lyon get that idea from you? A. Yes, I think they did.

Q. Prior to the time when you applied for patent, did Lyon & Lyon make a preliminary examination of the art in the Patent [272] Office to see what novelty might be involved in your idea?

A. I don't remember that.

Q. If they did, you do not have any report?

A. No, sir, I have never had a report of that, no.

Q. How long have you been in the oil business?

A. Sixteen years and three months with the Shell Oil Company. I have been with Shell since I left the University, with the exception of two months I worked for General Petroleum. I am in the production end of the business. I have not always been. At the time Mr. Wyatt and I collaborated on

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this, Mr. Wyatt was production foreman and I was a field engineer. However, in the production department.

Q. As to this Fig. 2 of the Lehr patent, your testimony would be like Wyatt's as to what would be used for recording these pressure impulse reflections?

A. Yes, sir. We appreciated, from our other method, and checking with some bailer runs that Mr. Wyatt referred to, in order to find how our velocity time was, to check the depth we would measure with a bailer, and we appreciated that the human element introduced a serious error into the method, and that a more accurate timing was necessary to secure greater accuracy, which is the basis for this recorder.

Q. And you knew that there were devices on the market which would record that a lot better than you were able to do mentally, or count the time mentally? [273]

A. Manually.

Q. You never made the apparatus of Fig. 2 of the patent?

A. Not of Fig. 2 of the patent, no sir.

Q. Did you ever make any recorder at all?

A. No recorder of this type shown in Fig. 2. There was a friend of mine who had something like a little bit of address system, with a microphone, in which an ammeter would jump in response to the sound, which we tried. But it gave no record; in other words, you would just look at

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it. There was definitely a microphone, and there was this—I think an ammeter, that would jump—I recall quite well of holding this thing to my stomach, and you would growl, and it would indicate on the ammeter.

Q. Had an amplifier, no doubt?

A. Undoubtedly an amplifier.

Q. That would have been something like this Fig. 2, if you left the recorder off and put just a visual indicating meter at that place instead of the recorder?

A. Do you mean by that that we would not have a strip chart to correlate time?

Q. Yes; you didn't have that, did you?

A. No, we did not.

Q. Well, you had a microphone, an amplifier, and an indicator; that is what you had? [274]

A. That is right.

Q. And you tried that out on a well?

A. Yes, sir.

Q. How did it work? A. Fine.

Q. When did you do that?

A. I believe that was after we filed the patent. I am not sure whether it was shortly before or just shortly after. It was right in there. Right at that time.

Q. Where did you put the microphone?

A. At No. 9 in Fig. No. 1.

Q. Right at that pipe?

A. Yes; we laid the microphone in there. As I recall it it was a little large, and instead of run-

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ning the pipe out at a steady diameter, we swedged it up just a little bit so we could lay it in there. The microphone, after being used several times in the presence of gasoline vapors, became less and less sensitive.

Q. And do you know what kind of a microphone that was?

A. No, sir. Let me say this, it was a carbon type of microphone, I do remember that—I don't know whether that is of any account or not, but this was the same type of microphone that we have in the transmitter on the telephone. The microphone was supplied by Harold Nichol. He is in charge of the meter shop for the production department of the Shell Oil Company. In [275] other words, he services drilling instruments, pressure recorders, and all types of that sort of equipment. We were just getting started in the other place.

Q. How many wells did you have this microphone on?

A. To the best of my knowledge, only one.

Q. How deep was it to the fluid level, do you know, about?

A. In those days we tried them pretty shallow, I would say it was less than 3500 feet.

Q. You had an impulse chamber, and a source of fluid pressure, like that shown in Fig. 1 of the patent.

A. Yes, sir, and a quick-opening valve. First we had our source of pressure gas or pressure fluid, as shown in Fig. 1. We filled the impulse cham-

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ber to the pressure we thought was about right, I imagine it was between thirty and fifty pounds; then we had that pressure there trapped, we shut valve No. 3, opened the quick-opening valve No. 6, and observed the ammeter. Then when the echo came back, we observed it flicker again—and I forgot to mention that we started our stop-watch at the time we opened the quick-opening valve, got it just the same as if we were holding our hand and watching the impulse.

Q. Did the needle flicker any?

A. Yes, sir.

Q. What do you think that was due to?

A. The echo coming back. [276]

Q. Well, I mean, in between the time that you opened the quick-opening valve and the time you stopped your stop-watch, as indicative of the reflection from the fluid level, did the needle flicker in between there any?

A. Well, as I recall, the needle got quite a bump on the first one, and the time was sufficient, that it quieted down by the time the echo came back.

Q. Well, there were some flickers then in between the first shot and the final reflection?

A. Rather than saying it was in between, I would say it was a rather prolonged disturbance from the initial shot.

Q. You don't think it could have been due to reflections from minor obstructions in the well?

A. In the particular well we were in, as I recall, there was none that we observed.

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Q. There was tubing?

A. There was tubing.

Q. And the tubing had collars?

A. Yes, sir, but those did not show on this microphone arrangement that we had.

Q. How do you know?

A. I could not tell it, I had absolutely no knowledge of it.

Q. But the needle was apparently vibrating, from what you said? [277]

A. Just initially. I am afraid we didn't have as sensitive a microphone, perhaps, as you have in mind. It jumped very much at first. Then it went clear back, and I could see no movement of it until we had the fluid reflection.

Q. Do you recall the circumstances relating to the transfer of some rights under this patent to Mr. Walker or the Depthograph Company.

A. Yes, I think I recall some of the general things.

Q. Did you disclose to him all that you have been telling us here this morning?

A. I don't believe I ever mentioned to Mr. Walker about the use of this microphone. As far as my knowledge of imparting information to Mr. Walker is concerned, I had only shown him Fig. 1 in operation.

Q. Was the transfer of these rights made after the patent issued, or before?

A. I don't remember.

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Q. Was there any other agreement, either oral or written, other than this one—I gather that you got a final written agreement, did you?

A. Yes.

Q. Was there any other prior agreement or anything of that kind?

A. There was nothing in writing. Mr. Wyatt is much more [278] familiar with that phase of it than I. I was not in Los Angeles at that time.

Q. He did the negotiating?

A. Most of it, yes, sir.

Q. For both of you?

A. Yes, sir. I was familiar with it after it was done, but meetings and things of that type, I was not familiar with.

Cross Examination

By Mr. Mattingly:

Q. At the time you tried out this device with the microphone, as you have described it here, you stated that there was quite a big bump at first, and then the needle of the meter later flickered as a result of receiving the echo from the fluid level. Do I understand you to mean, by that initial or first big bump, that that occurred at the time you opened the quick-opening valve to let the impulse go into the well? A. Yes, sir.

Q. And the second flicker of the needle was caused by the echo received back from the fluid surface? A. That is correct. [279]